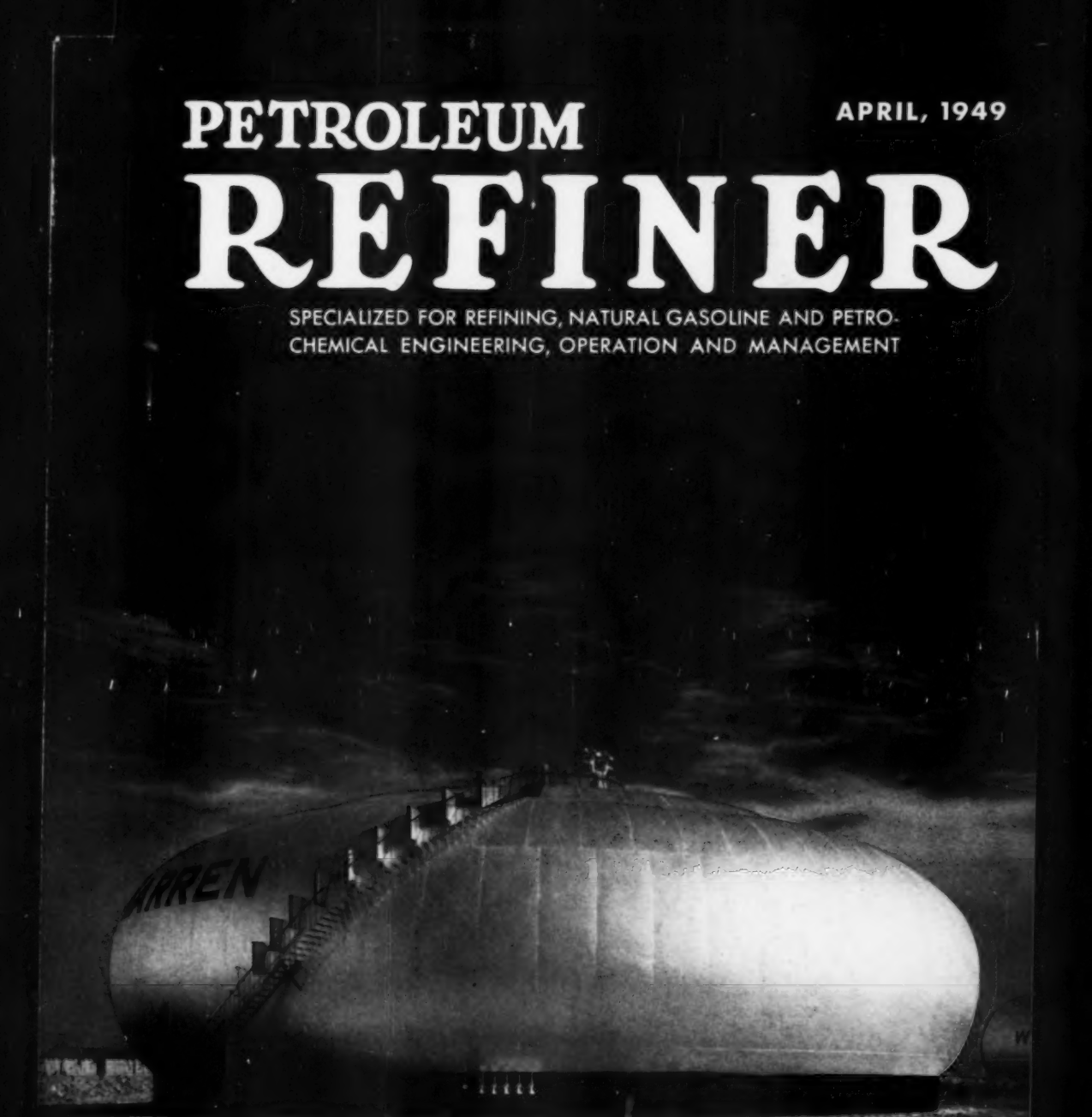
APRIL, 1949

PETROLEUM REFINER

SPECIALIZED FOR REFINING, NATURAL GASOLINE AND PETRO-CHEMICAL ENGINEERING, OPERATION AND MANAGEMENT



Everything about the Hortonspheroid reflects the thoroughness with which this modern type of tank has been designed to store volatile liquid hydrocarbons under pressure to prevent evaporation loss. Pressure settings from 2½ to 100 pounds per square inch; capacities to 120,000 barrels. Shown above is a 100,000-barrel noded Hortonspheroid.

CHICAGO BRIDGE & IRON COMPANY

ATLANTA • BIRMINGHAM • BOSTON • CHICAGO • CLEVELAND • DETROIT • HOUSTON
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SMALL TRAP

BIG *Performance*

Little? Sure. But what a giant's job they do!

That's how petroleum men judge Yarway Impulse Steam Traps.

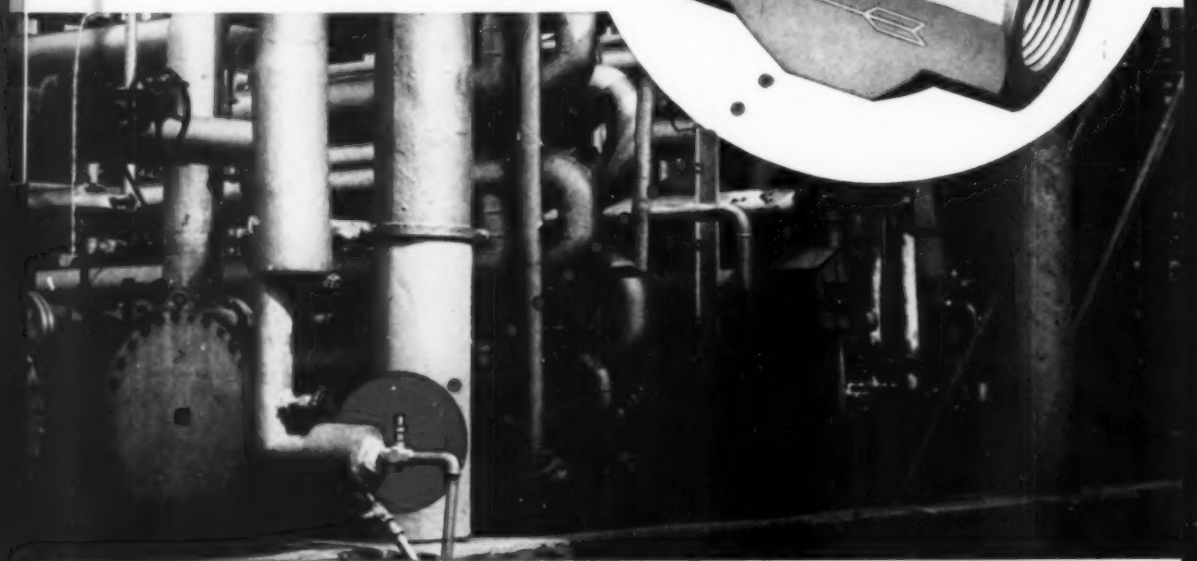
Yarways are well suited for refinery work. The small size itself is an important feature. They are easy to install, fit in anywhere, require no special supports.

In service they *drink* condensate, discharging *continuously* on heavy loads, at short *intervals* on light loads—providing maximum heat in the shortest time, and keeping equipment at top efficiency.

Yarways are suitable for all pressures without change of valve or seat. Simplicity of construction (only one moving part) minimizes maintenance. Also, initial cost is low.

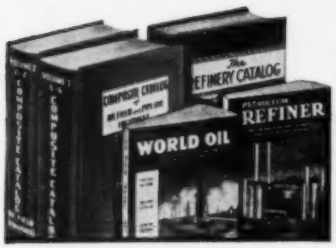
Try some Yarways today—standardize on them tomorrow. See your nearest Supply House or write for Yarway Bulletin T-1739.

YARNALL-WARING COMPANY
128 Mermaid Avenue, Philadelphia 18, Pa.



OVER 600,000 ALREADY PURCHASED

YARWAY IMPULSE STEAM TRAP



Specialized Oil Publications of
THE GULF PUBLISHING COMPANY
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PETROLEUM REFINER and The REFINERY CATALOG
for the refining-natural gasoline industry

WORLD OIL (formerly The Oil Weekly)
and The COMPOSITE CATALOG
for the drilling-producing-pipe line industry

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PETROLEUM REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

R. L. DUDLEY, President, Publisher A. L. BURNS, General Manager

VOLUME 28, NO. 4 APRIL, 1949

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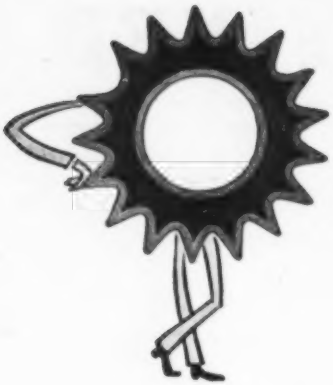

WE BITE CHUNKS OUT OF DOWNTIME

TOUGH COKE IS OUR MEAT!

When a bunch of us cutters starts down a tube, mounted on one of those Lagonda swing frame heads, Patton's tanks had nothing on us for covering territory!

It's a fight all the way, sure, but we're set for it—and how! We've got team-work plenty. Take a look at that big 1100 Series Lagonda motor with its ball thrust bearings at each end. There's power for you! Then imagine what happens when those long arms of the Lagonda swing frame head slams us cutters up against the coke! Boy, we go through like a bunch of All Americans through a high school eleven!

We keep going too! No delicate screw threads on our cutter pins to let go in the middle of a job. A hefty slug of metal in a good big slot holds those pins in. We're built for rough going, Mister.

Old Man Downtime ain't what he used to be—not when the Lagonda gang gets going. Try us out and see!

Lagonda straight cutters and cone cutters are of patented "trackless" design, with teeth so spaced that they do not consecutively contact the same spot in the tube. See the spacing of teeth in the star cutter above.

Lagonda

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Lagonda Division
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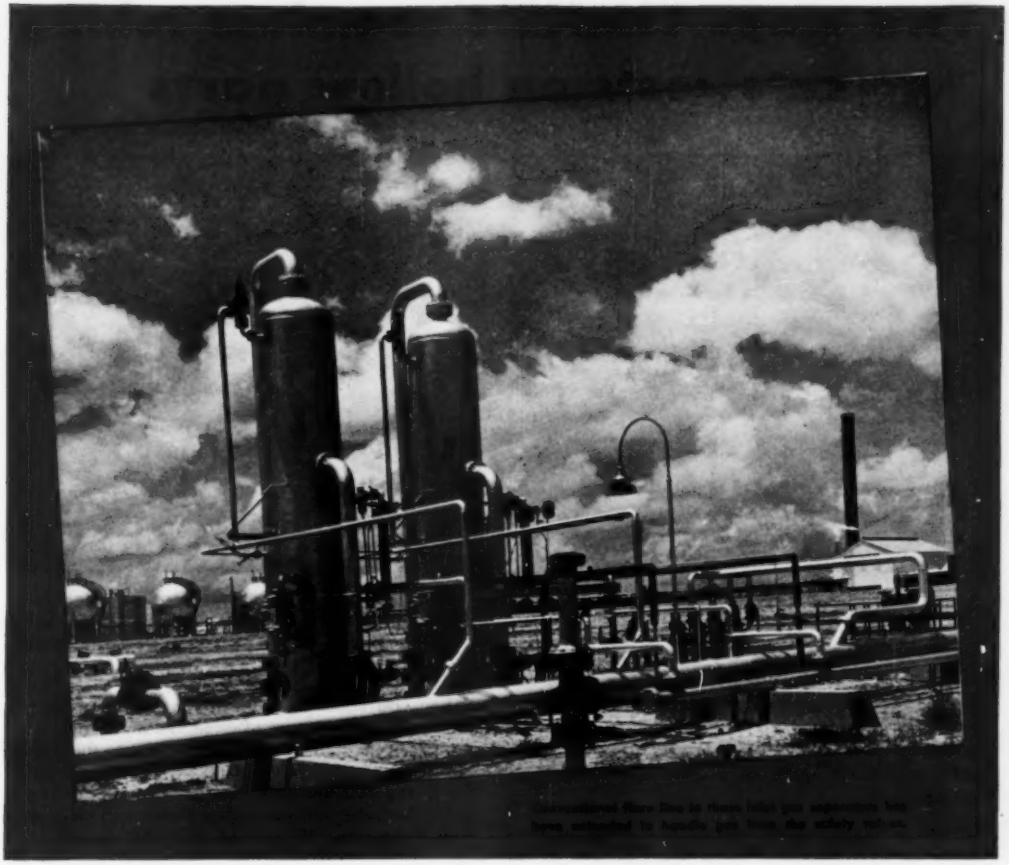
Y-285

STILL TUBE CLEANERS



Masterpiece in piping permanence

HERE'S another good example of the utilitarian beauty in permanently leakproof piping that distinguishes petroleum operations. The piping is welded, of course, and Tube-Turn welding fittings were extensively used.

There's nothing equal to welded piping when dependability is an absolute "must". And among welding fittings, none embody more manufacturing experience in this field than Tube-Turn welding fittings. They're tops in every quality for sound, maintenance-free piping.

Advantages of the leakproof welded joints go hand in hand with strength in the fittings proper equal to that of the connected pipe. Smooth inner walls, smoothly functional design assure minimum flow friction, reduce erosion and pressure loss. Dimensional accuracy, true circularity make for good alignment, perfect welds, high-speed piping assembly.

Got a piping problem? Talk it over with the Tube Turns distributor. He's backed for service by Tube Turns' outstanding piping research and development engineers.

TUBE TURNS, INC.

244 E. Broadway, Dept. F, Louisville 1, Ky.

District Offices at New York, Philadelphia, Pittsburgh, Chicago, Houston, Tulsa, San Francisco, Los Angeles

TUBE-TURN

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WELDING FITTINGS AND FLANGES

Keep up with the rapidly expanding line of Tube-Turn welding fittings. Write for TUBE-TURN CATALOG No. 111 SUPPLEMENT.

Two ways TIMKEN® seamless tubing cuts costs on hollow parts

1. No hole to bore

The first step in production is already finished when you use Timken® seamless tubing instead of bar stock for making hollow or ring-shaped parts. There's no hole to bore, less waste stock to pay for. Elimination of drills on automatic machines often leaves space for other tools, sometimes speeding production as much as 200 per cent!

Timken seamless tubing offers you a range of sizes up to 10½" O. D., covering a wide variety of requirements. Rigid control throughout every step in manufacture results in steels of fine forged quality and refined grain structure, with uniform machinability and heat-treating. This means a better product for you, with fewer rejects and increased customer satisfaction.

2. TIMKEN® tube engineering service gives you the most economical tube size—guaranteed to clean up.

When you make use of Timken tube engineering service, you can be sure of minimum machining time—maximum saving of metal. That's because the Timken tube engineering service takes full responsibility for giving you the most economical tubing for your particular job—and guarantees that it will clean up to your dimensions. We take all the risk!

This guaranteed service is made possible by the outstanding uniformity of Timken tubing and by the largest assortment of roll sizes of any mechanical tubing mill in the country. Get details of this service now—without cost or obligation. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

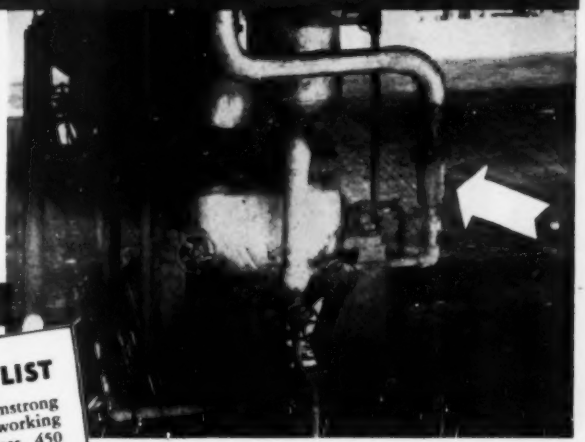
YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing

PETROLEUM REFINER, published every month. Entered as second class mail matter June 16, 1923, at the post office at Houston, Texas, under act of March 3, 1879.

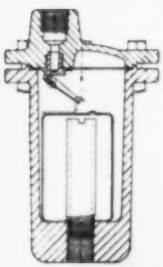
Forged Steel TRAPS FOR ALL PRESSURES

1. **High Shock Resistance.**
2. **Bodies Will Withstand Fire.**
3. **The Cost Is Low.**



No. 3211 — ONLY $14.00 LIST

Right—Here's the baby of the Armstrong forged steel line, a low priced trap for working pressures up to 250 psi—design pressures, 450 psi. Capacity range 750 to 1000 lbs/hr continuous. Diameter 4¼", height 7", weight 8 lbs. Available with ½" or ¾" connections. Standard Armstrong interior mechanism. Here's forged steel safety for only a few dollars more than a cast iron trap! Available for shipment from stock. Write today.



Cross-section of an Armstrong No. 3211 forged steel trap. Forged cap and body. Compressed graphited asbestos gasket. All stainless mechanism. This trap will take high temperatures and abuse without danger of fracture.

MORE and more refineries and natural Gasoline plants are using ARMSTRONG FORGED STEEL TRAPS, even at pressures as low as a few pounds. The extra safety in case of fire or an explosion more than justifies the moderate additional cost.

To use cast iron or semi-steel traps puts a weak link in the chain of steel pipe, steel fittings and steel valves. The shock of a distant explosion could fracture the cast iron traps.

Why take a chance when Armstrong forged steel traps cost so little more than cast iron?

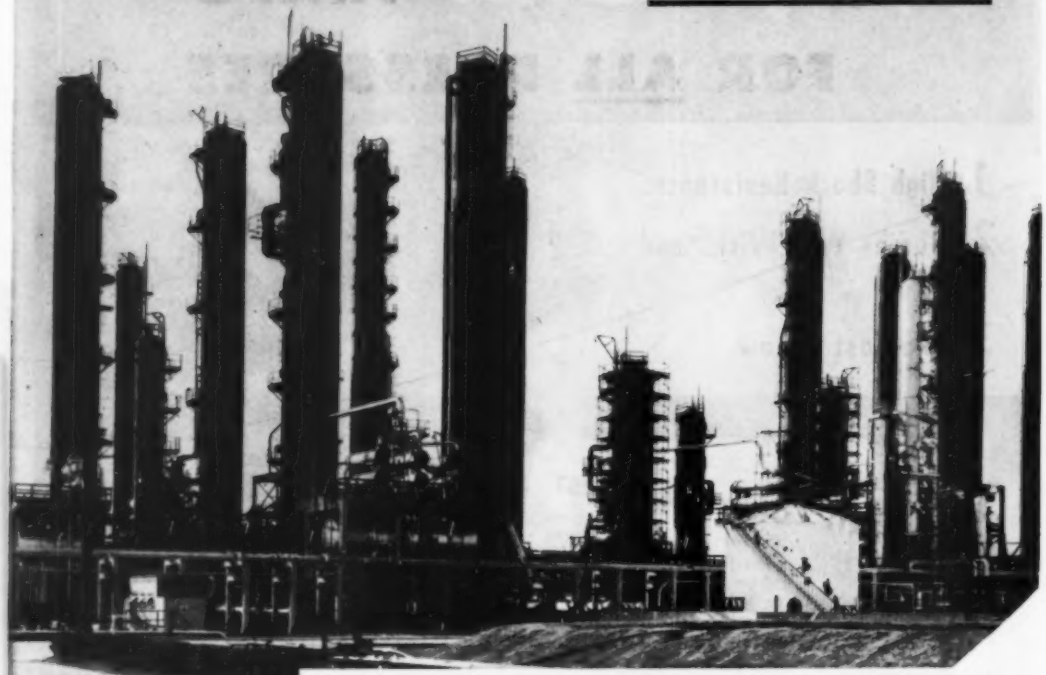
A "standard" in high pressure power plants throughout the world, Armstrong forged steel traps are the perfect answer for extra safety and dependability in the petroleum industry. Prices are modest. For complete data, send for your copy of the ARMSTRONG STEAM TRAP BOOK.

ARMSTRONG MACHINE WORKS
852 Maple St., Three Rivers, Michigan

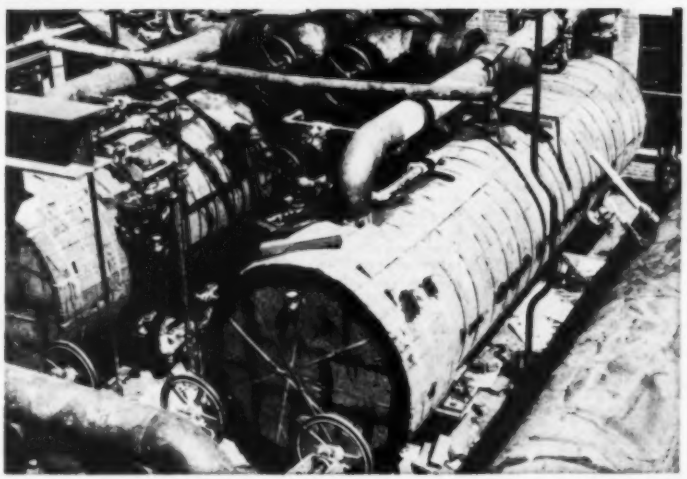
ARMSTRONG STEAM TRAPS

Factory Representatives in 48 Key Cities... Traps Stocked at 147 Points

Insulate the first time



This picture of the Neches Butane Products Company's plant at Port Neches, Texas, shows a variety of fractionating towers, all insulated with PC Foamglas.

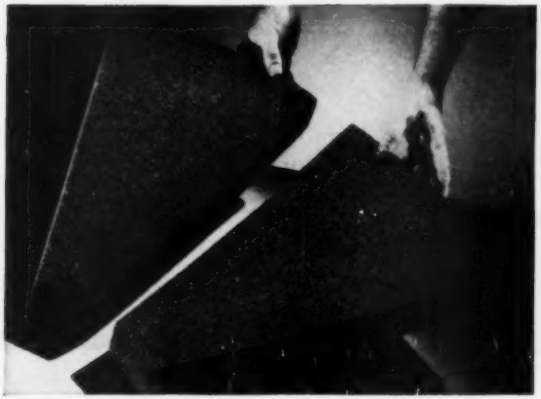


This picture shows how PC Foamglas is used to insulate tanks and pipe lines. The material is available in standard blocks, curved segments and beveled lags to fit tank sides, heads and domes and in preformed sections for standard pipe sizes and fittings.

PITTSBURGH PC CORNING

FOAMGLAS INSULATION

for the last time with PC FOAMGLAS



These are curved segments of PC Foamglas for use on tank heads. PC Foamglas can be easily cut and formed with ordinary tools, to fit all sorts of irregular shapes.

the permanent material for industrial insulation

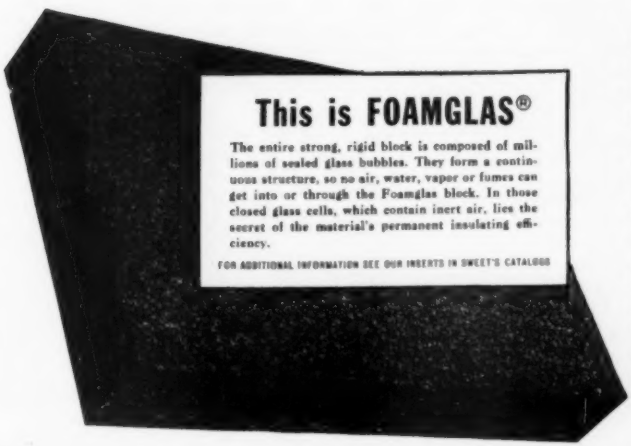
It's Acidproof, Fireproof, Waterproof

Replacements—repairs—maintenance—those are the main reasons why costs mount up when you use ordinary insulating materials. That is why so many plant engineers are saving time, trouble and money by insulating tanks, towers, retorts, hot and cold piping, ducts, breeching, evaporators, heat exchangers—and other processing equipment—with PC Foamglas.

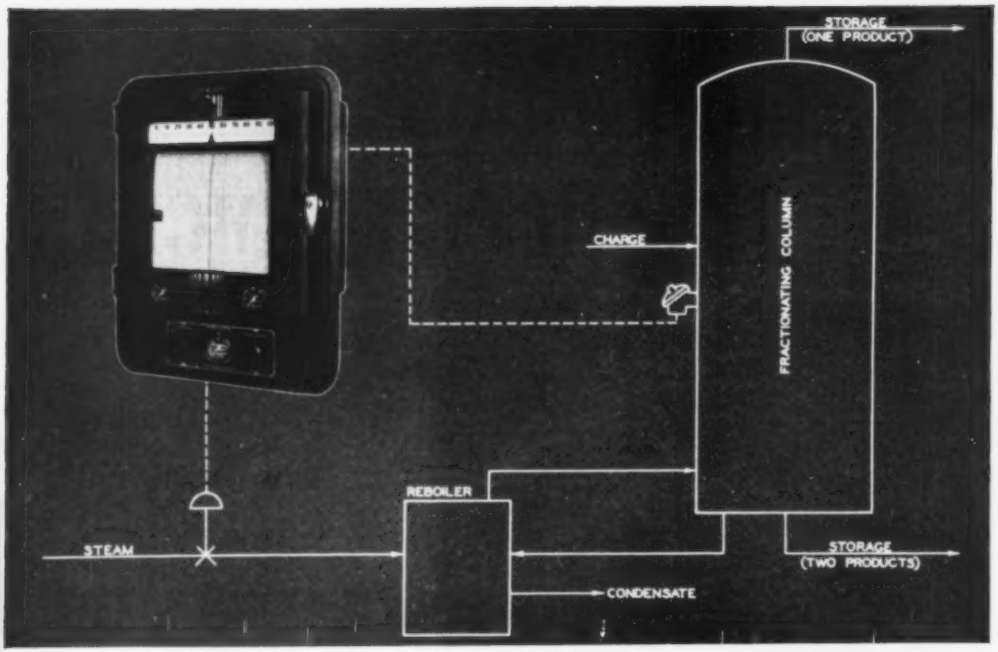
PC Foamglas is true glass in cellular form (see illustration). It is therefore impervious to moisture, fire, vapor, fumes, acids, most solvents and other elements that cause many materials to lose insulating efficiency in processing plants.

First cost is last cost when you insulate with PC Foamglas, because, when installed according to our recommendations and specifications, this unique material retains its original insulating efficiency *permanently*.

Our insulating specialists will be glad to help you work out your individual insulating problems, to show you where and how you can use Foamglas to the best advantage. Just drop a line, without obligation, to Pittsburgh Corning Corporation, Dept. T-49, 307 Fourth Ave., Pittsburgh 22, Pennsylvania.


This is FOAMGLAS®
The entire strong, rigid block is composed of millions of sealed glass bubbles. They form a continuous structure, so no air, water, vapor or fumes can get into or through the Foamglas block. In those closed glass cells, which contain inert air, lies the secret of the material's permanent insulating efficiency.
FOR ADDITIONAL INFORMATION SEE OUR INSERTS IN SWEET'S CATALOGS

When you insulate with Foamglas...you insulate for good!



This Tower's Costly Cycling Stopped By Speedomax Control

An L&N Field Engineer seated himself in the office of the Process Engineer of a large chemical plant. "How'd that new Speedomax Controller work out?" he asked. "Last time I was here you were installing it to handle that mid-tower control point, separating one component out of three in the tower charge."

The Process Engineer nodded. The Controller, he said, had worked out well. Other controllers had not been successful for that fractionation, because none had been able to overcome an upset without considerable cycling. And cycling, when it happened, could cost as much as a hundred dollars a minute for lost production. So . . .

"Pardon me, the L&N man interrupted, "Did you say a hundred dollars a *minute*?"

Yes, the Process Engineer said, cycling could cost one hundred bucks every 60 seconds—and could last for a quarter of an hour, in bad upsets. So, he had been interested in this new L&N control, and didn't lose much time in putting one on that tower.

Then he had run a little test, just to prove what he was getting in the way of superior control. He had thrown an upset into the tower, and watched how long it took Speedomax to bring the temperature back into line. Then he switched to the older controller, and threw in the same upset. It took the other instrument just three times as long as Speedomax — and, at that hundred dollars a minute, he felt that Speedomax was paying for itself mighty fast!

This control problem was not, technically, particularly tough; it got the spotlight because of the great value of the chemical being processed. But, whether an occasional cycling costs your plant a hundred dollars or only a dollar a minute, we think an examination of the possibilities of L&N Control would be worth your while. We will be glad to talk it over, or will send our new Catalog ND4B if you prefer.

Write Leeds & Northrup Company, 4923 Stenton Avenue, Philadelphia 44, Pa.

MEASURING INSTRUMENTS • TELEMETERS • AUTOMATIC CONTROLS • HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

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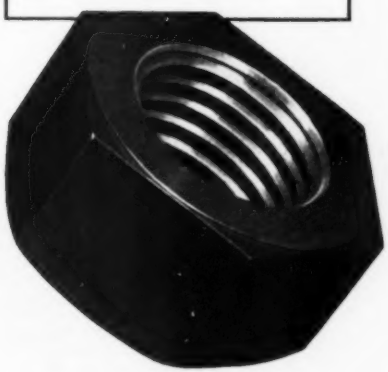
IT'S RIGHT AT HOME IN

High-Temperature Service

The Bethlehem Quenched Nut is a product of BETHLEHEM'S LEBANON, PA., PLANT



For a nut that's right at home in the high-temperature bolting jobs encountered in refineries, choose the Bethlehem Quenched Nut.

The Bethlehem Quenched Nut is ideal for tough bolting jobs for two reasons: (1) it is carefully made from medium-carbon steel, and (2) it is both hot-forged and quenched. This method of manufacture provides the hardness and ductility needed to withstand difficult bolting conditions.

What about strength? Tests prove that the Bethlehem Quenched Nut has sufficient strength to break *any* stud or bolt on which it is used. What's more, the nut has uniform threads, and its oxidized sides are more than a match for atmospheric corrosion.

The Bethlehem Quenched Nut comes in all bolt sizes from ⅜ in. to 3½ in., inclusive. It fully meets ASTM specifications for a Grade 2H nut. How about putting it to work for you?

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

★ BETHLEHEM STEEL ★

Bethlehem supplies every type of Fastening

Any mesh, any weave in the *Screen* and *Filter Cloth* you need!

HAVE you ever replaced fabric or metal cloth, and thought, *"Why can't I get cloth with better life?"*

The answer is, you *can*. 33 quality weavers produce wire cloth of Monel*, Nickel and Inconel* in all meshes and weaves. Called "task metals," these metals are ready for your toughest jobs.

Wire cloth of Monel, Nickel or Inconel is rustless . . . corrosion-resisting . . . strong . . . tough. It stands abrasive wear. It endures extremes of temperature. It guards product purity.

It is probably just the kind you want . . . and *need*. Prove its superiority by running a comparative-life test right in your own plant.

The cost is another reason for trying it. The easy workability of these metals enables weavers to produce cloth of Monel, Nickel or Inconel at prices comparable to what you are now paying for less durable metals. *Fine weaves of Monel often cost less!*

Seams are readily brazed, *soldered or welded; retain full corrosion resistance. For booklet,* **"ESTABLISHED WEAVERS,"** *write to our Frank Bailey*

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

*Reg. U. S. Pat. Off.

EMBLEM OF SERVICE
INCO
TRADE MARK

Monel® *Nickel* *Inconel*®

"Task Metals" for Industry

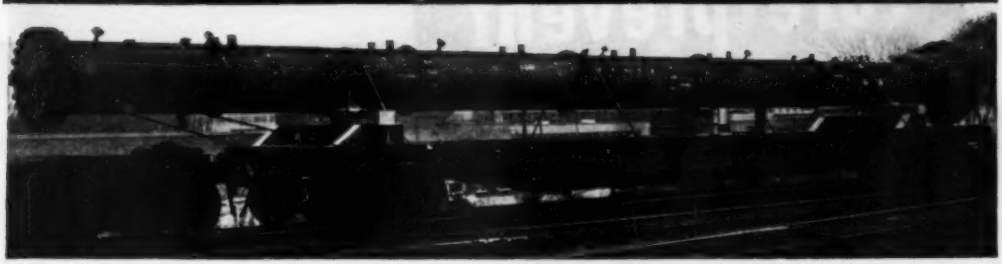
VESSEL DIVISION

NEWS

75th ANNIVERSARY 1874 · 1949

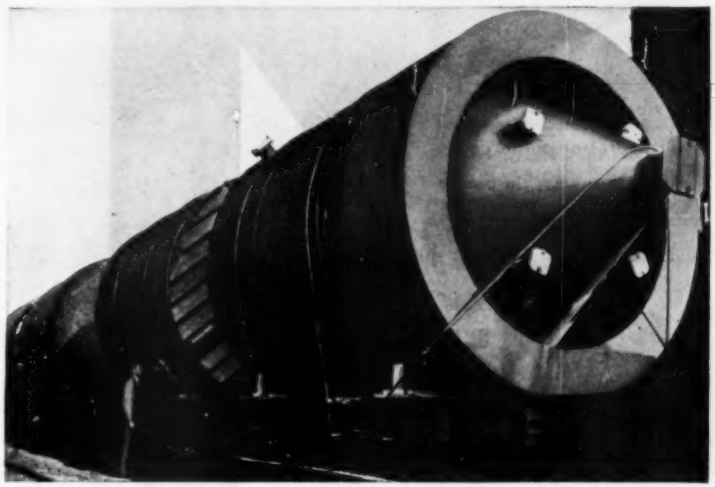
A. O. SMITH Corporation

New York 17 · Philadelphia 5 · Pittsburgh 19 · Atlanta 3 · Chicago 4
Tulsa 3 · Dallas 1 · Houston 2 · Seattle 1 · Los Angeles 14
International Division: Milwaukee 1

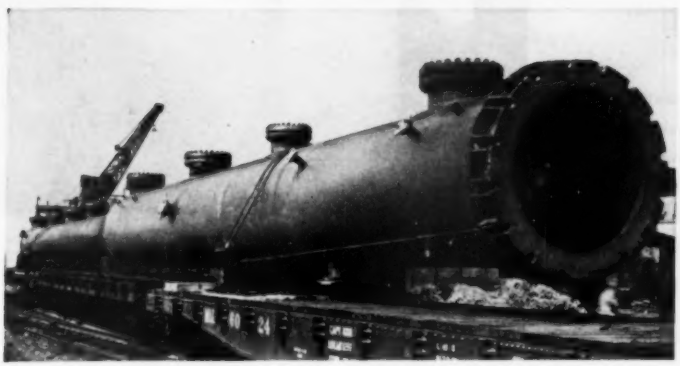


INTO EVERY SMITHlined FAT-SPLITTING TOWER, like the above 68-ft.-long SMITHway Tower, goes the experience and knowledge gained from a long and extensive program of research and development into the corrosion problems of the Fatty Acid Industry.

THREADING A NEEDLE. Getting a 12 ft. dia. by 43 ft. long paper mill replacement digester into an existing building is a difficult feat. A. O. Smith did it by shipping the SMITHlined Digesters *in sections* for final assembly and welding in place inside the paper mill.



A. O. SMITH MAKES ALL TYPES OF OIL-REFINING PRESSURE VESSELS. Here is one type, a SMITHlined Absorber Tower three railroad cars long (approximately 107 ft. long), leaving for a refinery in Ohio.



NEW BULLETINS

Write the nearest A. O. Smith office listed at the top of this page for these new A. O. Smith Bulletins:

FIELD ASSEMBLY OF PRESSURE VESSELS – Bulletin V-44.

SMITHway VESSELS, Alloy, Alloy-Lined, Clad, and Glass-Lined—Bulletin V-46.

cure·prevent *pipe-line quivers with* FLUOR Pulsation Dampeners

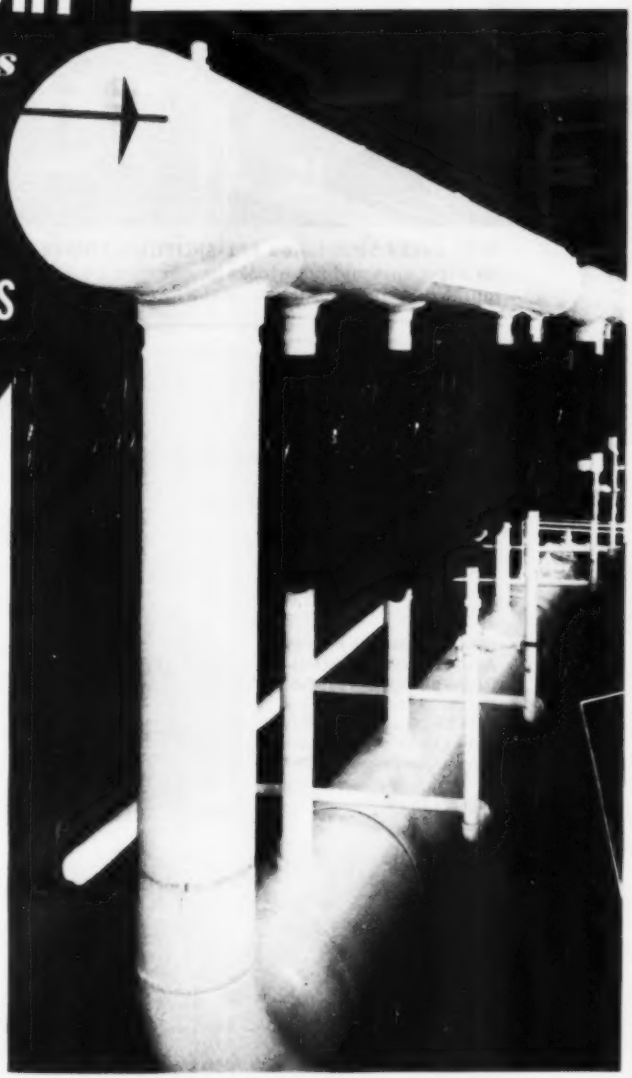
Pipe vibration from gas-compressor pulses costs money—in repairs, in power consumption, and in meter inaccuracy. It can also cost Human Life.

1 cure

Where pulsative gas flow is already setting up destructive vibrations and instrument irregularities, Fluor pulsation dampeners can be installed as a complete remedy.

2 prevent

On new installations, wherever there is danger of pulsation, you can safeguard compressor efficiency, reduce operating costs, and avoid headaches in general with proper pulsation-dampening units. You **save** money by buying Fluor pulsation dampeners to **remove** pulses instead of buying oversize pipes with necessary anchorages to **resist** them.



Fluor pulsation dampeners were installed as original equipment on the 1200-mile natural gas line from West Texas to Southern California. This view in a main line station at Tucson, Arizona shows Fluor pulsation dampeners on both the suction and discharge sides of the compressors. These dampeners are paying for themselves by permitting the required gas flow to be maintained with minimum horsepower. photo by Elwood M. Payne

BE SURE WITH FLUOR

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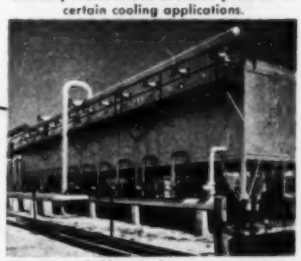
aerator towers

Fluor Aerator cooling towers have distinctive economy features and are most practical in certain cooling applications.

fin • fan units



Fluor air-cooled heat exchangers are more economical where make-up water is expensive, where water has bad scaling characteristics, and where the temperature of fluid to be cooled is relatively high. (Manufactured and sold by Fluor and Griscom-Russell Co.)

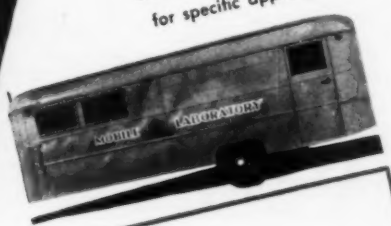
counterflo towers

Fluor Counterflo induced-draft cooling towers are a standard of industry for most water-cooling applications. They deliver "colder water cheaper."

gas cleaners

The Fluor gas cleaner, already well-known for efficient cleaning, has been redesigned to give still better performance.

This is the Fluor mobile pulsation laboratory that has traveled many states on the trail of plant pulsation problems. Fluor pulsation dampeners are individually "tailored" for specific applications.



mufflers

Fluor mufflers, redesigned to incorporate pulsation-dampener principles, reduce exhaust-line noises to less than the mechanical noises of the compressor room.

"but... our tubing problem is DIFFERENT"

Probably Nothing Was Ever Truer. In Oil Refining There Are Perhaps Nearly as Many Tubing Problems as There Are Tubing Installations.

☆

To help solve your tubing problems, the technical staff of The Pressed Steel Co. offers you a wealth of experienced engineering assistance and production know-how, gained through the almost quarter-century we have been supplying welded alloy equipment to the refining industry. Send blue prints or write us to your needs.

PRESSED STEEL CO. WELDED TUBING IS

Alloy-Right for Every Operating Condition

We fabricate from the complete list of alloys, selecting the one that meets your problem.

Take any tubing assembly in your refinery. Obviously, if it were made of the one alloy that best meets the temperature, corrosion, pressure, abrasion, or oxidation problems involved, it would be subject to the least trouble and would show the best possible life/cost ratio. The Pressed Steel Co. enables you to enjoy these very real advantages, because we fabricate tubing from the complete list of alloys which are available today from any source. Tell us the operating conditions your tubing must face. We will then select the one alloy that best meets your specific requirements.

Diameters Up to 60"
Temperatures to 2200°F

'Pressed Steel' welded alloy tubing is furnished in standard and special sizes and shapes: any wall thickness from 1/16" to 5/16"; any diameter up to 60"; temperatures to 2200°F. It can be readily bent, coiled, swaged and formed; and butt-welded to make any required length. Chemical and physical perfection of 'Pressed Steel' tubing is assured by hydrostatic, tolerance, surface and straightness tests.

THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

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Improve your cutting oils with Twitchell Base

Photo Courtesy South Bend Lathe Works

Cutting and Grinding oils compounded from Twitchell 8262 Base have five distinct benefits that add up to *improved shop performance.* Besides—they provide competitive advantages which your own sales department can sell to your customers with assurance.

COMPOUNDING

Little if any final adjustment is required. Twitchell 8262 Base is "pre-adjusted" against a sample of your lubricating oil to simplify final compounding and to insure satisfactory working properties in finished oil.

OIL STABILITY

Finished oils are clear and non-scumming. They stay that way because Twitchell 8262 Base contains no volatile coupling agents. Compatibility assured by pre-standardizing base against your oil.

EMULSION STABILITY

Specification for oil separation and creaming are checked on each shipment of base to further guarantee superior emulsion stability in your finished oils. Emulsions of soluble oils containing Twitchell 8262 Base have little tendency to foam.

As little as 12% Twitchell 8262 Base provides satisfactory emulsions for cutting oils. Clear grinding oils require higher percentages.

HARD WATER PERFORMANCE

Twitchell Bases effectively resist hard waters. Emulsion stability can be assured under extreme conditions by slight increases in amounts of base used.

ANTI-RUSTING PROPERTIES

Twitchell 8262 Base adds definite anti-rusting properties which protect machined parts during shut-downs or temporary storage periods.

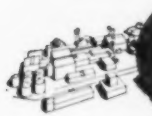
Send for further technical information on this and other outstanding Twitchell Bases. Write today!

FOR RUST-PREVENTIVE COMPOUNDS

Emery 2221

Glyceryl Mono-oleate

Tests show superior rust-preventive qualities of anti-rust compounds with Emery 2221, glyceryl mono-oleate, as an active ingredient. Compatible with liquid and solid or semi-solid vehicles, Emery 2221 features high mono-ester content and minimum free glycerine.



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CINCINNATI 2, OHIO

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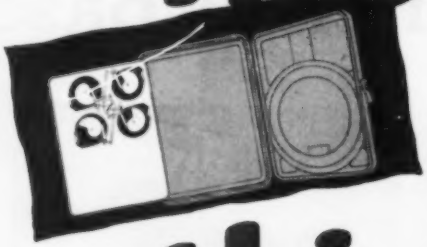

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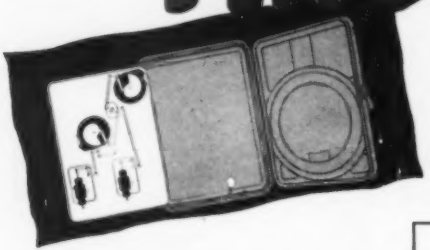

More than 100,000 different instrument combinations are now possible from four basic circuits and eight basic component parts. That's how Bailey has simplified electronic controls for processing industries.

No matter what your process may be, you can use Bailey controls for flow, temperature, pressure, level, speed, gas analysis, pH, conductivity, etc. Four circuits and eight basic parts are all you need. You don't have to carry a large stock of replacement parts. Bailey parts are interchangeable. The units you use for one control can quickly be adapted to another.

To learn how Bailey controls can save you money and speed up control installations, write for a copy of Bailey Bulletin No. 17.

or 100,000 other instrument combinations
. . . with 4 circuits . . . 8 basic parts . . .

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BAILEY METER CO. LIMITED, MONTREAL
Controls for the Oil Industry
TEMPERATURE • FLOW • PRESSURE
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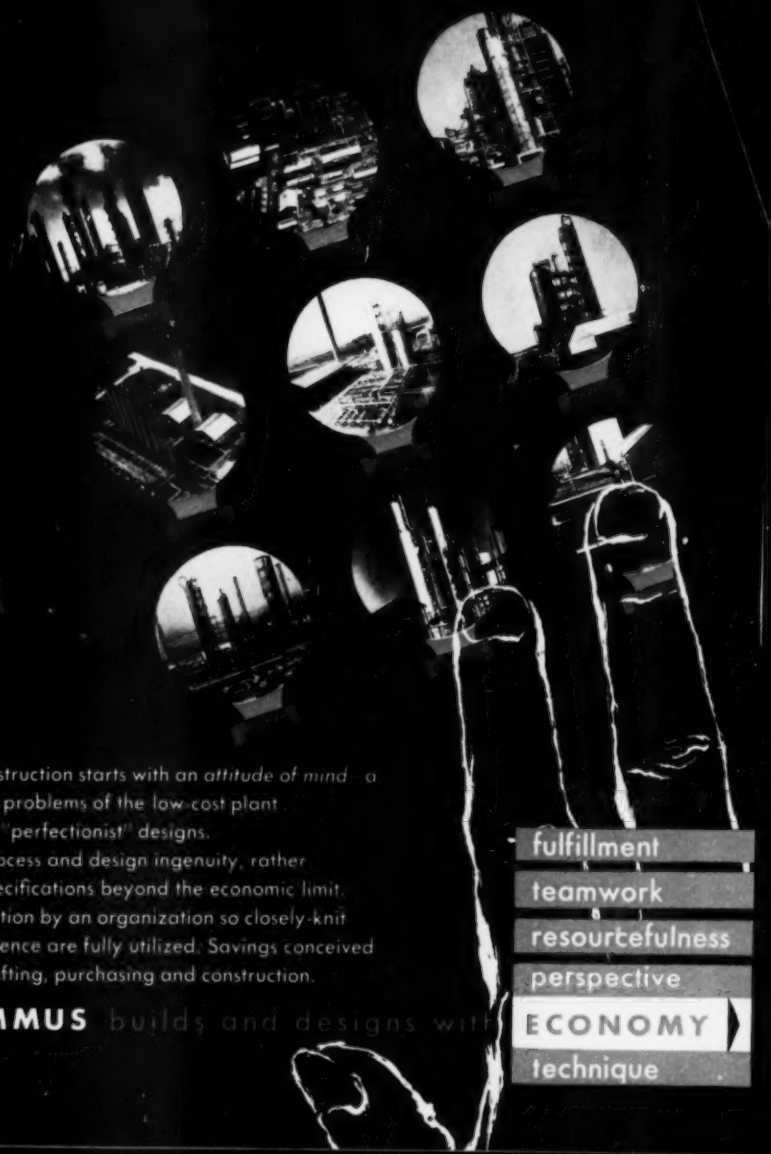
4 + 8 Works Here . . .
Port Arthur Refinery of Gulf Oil Corporation where Bailey Instruments are helping to refine petroleum.

ECONOMY



Economy in plant design and construction starts with an *attitude of mind* a willingness to apply to the practical problems of the low-cost plant the same enthusiasm given to "perfectionist" designs.

Operating economy is sought by process and design ingenuity, rather than by ultra-refinement of specifications beyond the economic limit.

Economy is carried through construction by an organization so closely-knit that the lessons of past experience are fully utilized. Savings conceived in design accumulate through drafting, purchasing and construction.

LUMMUS builds and designs with

- fulfillment
- teamwork
- resourcefulness
- perspective
- **ECONOMY**
- technique

ECONOMY by prototype—Time was money, in furnishing a new solvent dewaxing lube oil plant to replace one destroyed by fire. Lummus completed the job in 20 weeks—saved in first cost as well—by adapting the well-established features of previous designs. Four subsequent units followed the same prototype. This approach to standardization offers many opportunities for savings.

ECONOMY by conversion—A newly completed modernization project has converted a 19,000 B/D topping-cracking unit, running on sweet crude, to a 30,000 B/D combination topping-coking plant handling sour crude. Existing towers, heaters and other facilities were utilized. The coking unit was first built around existing facilities, without interfering with operations.

ECONOMY by expediency—This smaller customer had rigid limits of first cost for its lube oil plant. Lummus accepted the challenge—the design was developed to permit use of existing and rebuilt equipment—located and purchased by Lummus for the job. This plant has maintained a high operating record and low operating costs.

ECONOMY by experience—An experienced, well-knit organization was the key to economy on this atmospheric and vacuum distillation unit, designed, delivered and completed in South America all within 6 months. By foreknowledge of shipping procedures, local labor conditions and careful planning, costly "emergencies" were avoided in advance.

THE LUMMUS COMPANY
420 Lexington Avenue, New York 17, N. Y.

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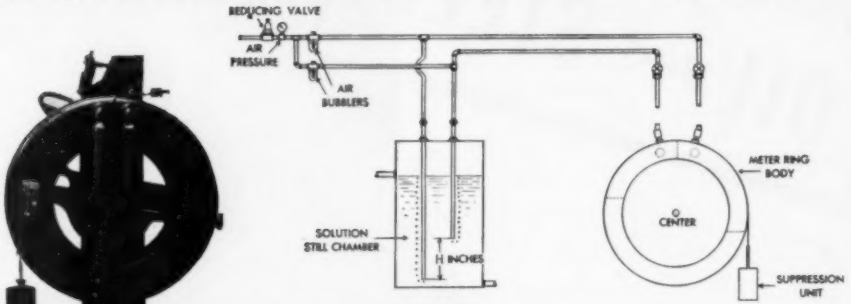
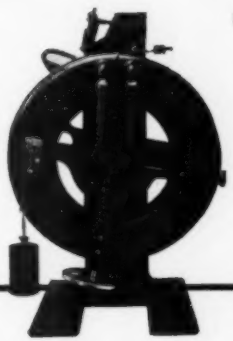
LIQUID SPECIFIC GRAVITY

is easily measured with

HAGAN RING BALANCE METERS





Almost any meter based on the differential pressure principle might be used to measure the specific gravity of liquids—but it can be done most easily and accurately with Hagan Ring Balance Specific Gravity Meters.

One simple method, utilizing a still tank, is shown in the diagram. Differential pressure in this arrangement is a function of the distance "H" and of the specific gravity of the liquid. The necessary pressure differential can be created in a number of other ways, the design of the meter, particularly its sensitivity to low differentials, giving the user wide latitude in this respect.

It is often desirable to make the full width of the meter chart available for recording only the range of specific gravities encountered in a specific application. With the Hagan Ring Balance Meter, this is accomplished by hanging a suppression weight on the ring body. No other meter affords so simple and accurate a method of suppression.

The same basic arrangement may be used to control specific gravity of any liquid, for control mechanisms are easily added to any Hagan Ring Balance Meter. Addition of a second ring which measures the liquid flow, can give the user a specific gravity compensated flow meter. Temperature or pressure compensation, or both, may be added.

A chart record of these quantities can be provided, together with compensated and uncompensated records of specific gravity.

For full information on this and other applications of Hagan Ring Balance Flow Meters, just fill out and mail the coupon below. Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

HAGAN CORPORATION
Hagan Building
323 Fourth Avenue, Pittsburgh 30, Pa.

Please send full information on Hagan Ring Balance Flow Meters. I am particularly interested in the application described below.

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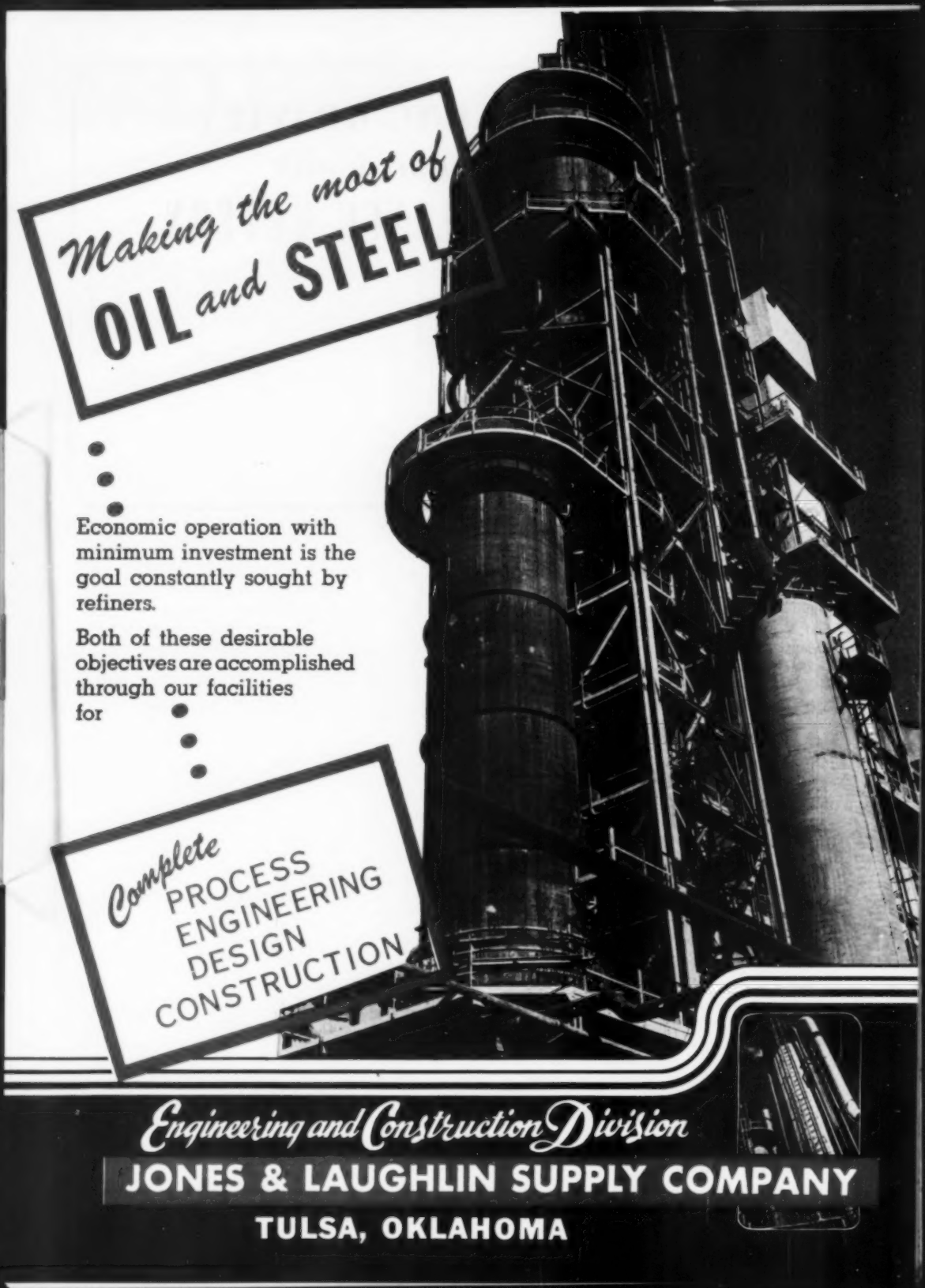
Making the most of
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Economic operation with minimum investment is the goal constantly sought by refiners.
Both of these desirable objectives are accomplished through our facilities for
Complete
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JONES & LAUGHLIN SUPPLY COMPANY
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It's CRANE for complete selection

...on any refinery piping job

ONE SOURCE OF SUPPLY
RESPONSIBILITY
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Take this vapor recovery process piping, for example. Every item for the system is in the Crane line. **One catalog** places at your finger tips the world's greatest selection of valves, fittings, accessories and pipe. **One order** to your local Crane Branch or Wholesaler covers all your needs—in brass, iron, steel and corrosion-resistant alloy materials.

To standardize on Crane as your **One Source of Supply** is to simplify all piping procedures, from design to erection to maintenance. **Complete Responsibility** on Crane for all piping delivered to the job helps you to get the best installations, avoid needless delays. And the traditionally **High Quality** of every item from Crane means continued, dependable service from process piping systems.

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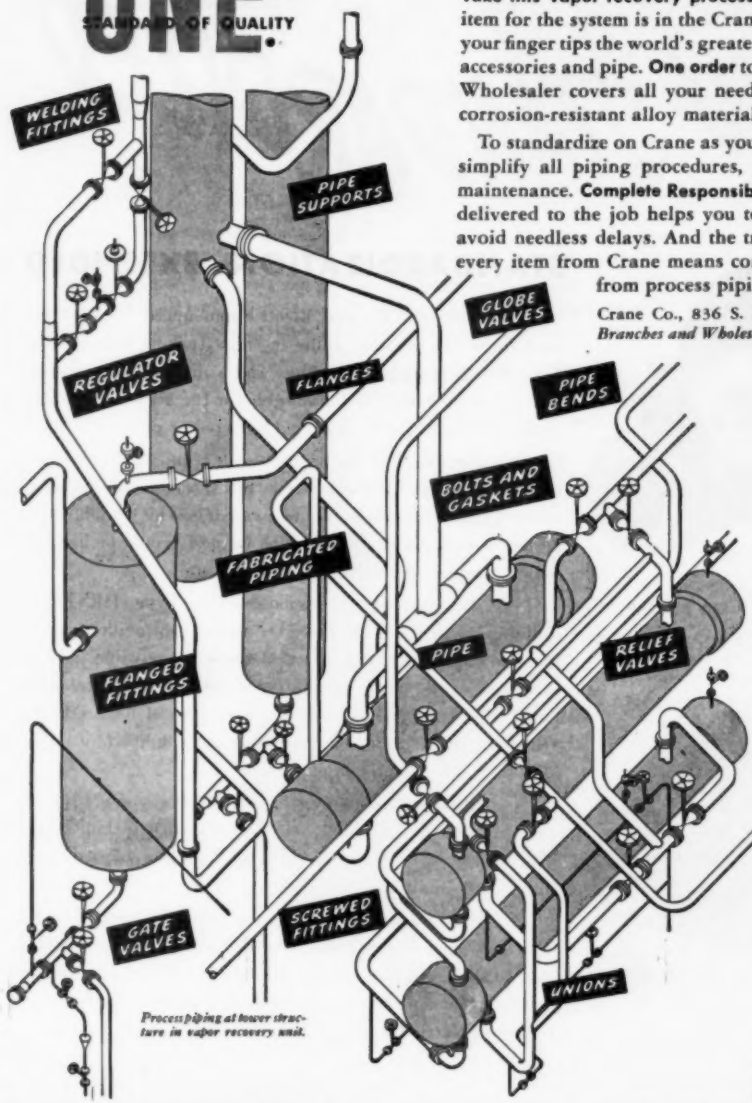
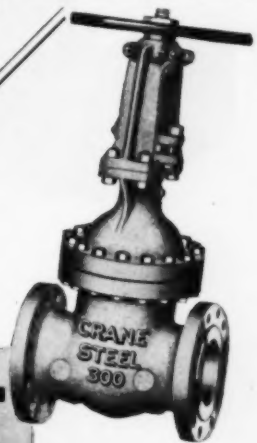


Process piping at tower structure in vapor recovery unit.

STEEL VALVES FOR PETROLEUM PROCESSORS—*Crane No. 33X 300-pound Cast Steel Wedge Gate Valve. Trimmed to handle oil and oil vapor at temperatures up to 1000 deg. F. One of a complete line of steel valves for all refinery services. Crane gates, globes, angles, and checks are available in pressure classes from 150 to 2500 pounds. Flanged, screwed, or welding ends. See your Crane Catalog.*



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FOR EVERY PIPING SYSTEM

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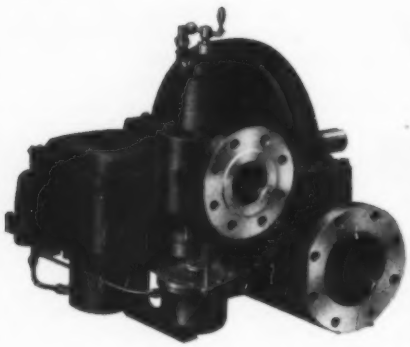
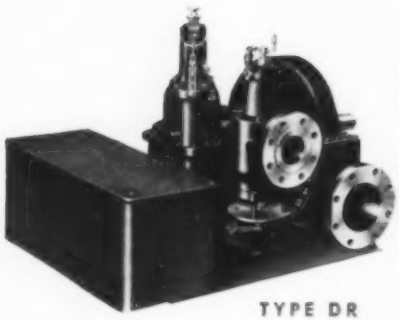


TYPE DP



TYPE DR

STANDARDIZATION EXTENDED

Last year General Electric announced what we believe to be the greatest value in small turbine history—the Type DP. This standard turbine, which offers a host of special features at no extra cost, is suitable for the great majority of applications within its speed and horsepower range.

For drives of higher speeds, or requiring wider speed range, or greater accuracy of control, the new oil-relay governed Type DR turbine is now available. This standardized design powers many drives which formerly could be handled only by a more expensive, custom-built unit.

To simplify maintenance, the Type DR is coordinated with the basic Type DP design to provide as much standardization of parts and dimensions as possible. For instance, bearings, packings, shafts, oil coolers, and many other parts are interchangeable on all frame sizes of both DP and DR units. Installation and re-location are simplified by a common shaft height and coupling fit.

By the selection of a Type DR drive, you get the advantages of a custom-built, oil-relay governed turbine, along with the ease of maintenance and handling offered by a standardized unit.

For assistance in applying the right turbine to the right job, get in touch with your G-E representative. He'll be glad to show you how the special features of G-E mechanical-drive turbines offer you extra value. Apparatus Department, General Electric Company, Schenectady 5, N. Y.

TURBINE!

FOR

HIGH SPEEDS,

WIDE SPEED RANGES, GREATER ACCURACY OF CONTROL

The new Type DR turbine is almost universally applicable within its range of ratings. Speed range under governor control is more than sufficient to handle all types of variable speed pumps, fans, compressors, blowers, stokers, and many types of paper machines. The accuracy afforded by the standardized, oil-relay governor even permits smooth parallel operation of a-c generators.

Ratings up to 1500 hp are available, with speeds from 1000 to 8000 rpm.

SAFE IN EXPLOSIVE ATMOSPHERES—non-sparking emergency governor standard on all units

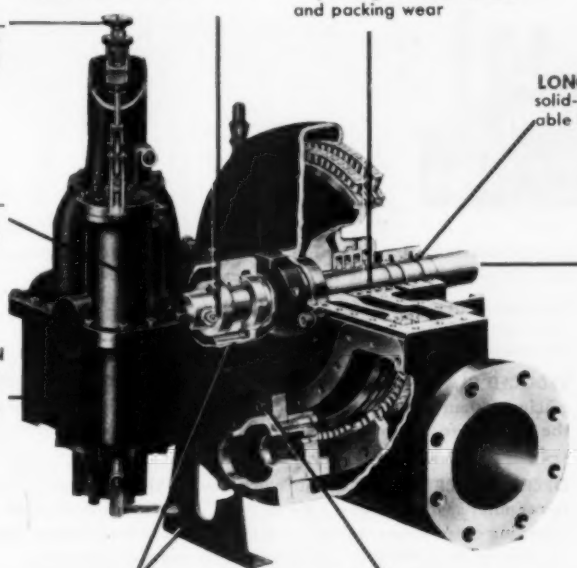
LESS MAINTENANCE—Monel spraying of journals at packings reduces erosion and packing wear

WIDE SPEED RANGE—powerful oil-relay governor provides adjustable speed range up to 5 to 1

LONG-LIFE BEARINGS—solid-backed interchangeable bearings

GREAT ACCURACY—steady state governor accuracy of ±¼ of 1 per cent

EASY TO INSTALL—standard shaft height and coupling fit permit installing and re-locating units with a minimum of effort



POSITIVE LUBRICATION—pump provides pressure lubrication for turbine bearings and, if desired, for driven equipment

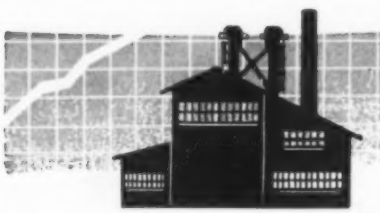
PERMANENT ALIGNMENT—center-line support eliminates casing strains, keeps unit in alignment, reduces coupling wear

EASY TO DISASSEMBLE—casings and other parts secured by easy-to-handle socket-head cap screws, which replace conventional bolting

GENERAL ELECTRIC

ATTAPULGUS "AAA"...

A new percolation clay
Setting new efficiency records



Attapulgus—foremost name in fullers earth—now offers a *new* percolation clay, the high efficiency of which has been proved by many months use in one of the larger oil refineries in the country.

Its name—Attapulgus "AAA" Grade Clay.

Its record:

REDUCED CLAY COSTS. With most oils, "AAA" has 10% to 20% more refining efficiency than other available percolation clays—a superiority maintained over the entire life of the clay. This permits using "AAA" through more cycles, reducing clay costs by 15% to 25%.

OPERATING CREDITS. The higher percolation yields per ton of "AAA" clay mean fewer filter turnovers, less clay to burn, lower oil and naphtha losses, reduced steaming costs, lower maintenance costs on burner equipment, etc. These savings are two to three times as great as the reduction in clay costs.

INCREASED YIELDS. Just install "AAA" and yields go up. The same production can be maintained at a lower unit product cost. Or, "AAA" will give your present facilities added capacity.

"AAA" Grade Clay is available in standard percolation meshes—in bags or bulk.

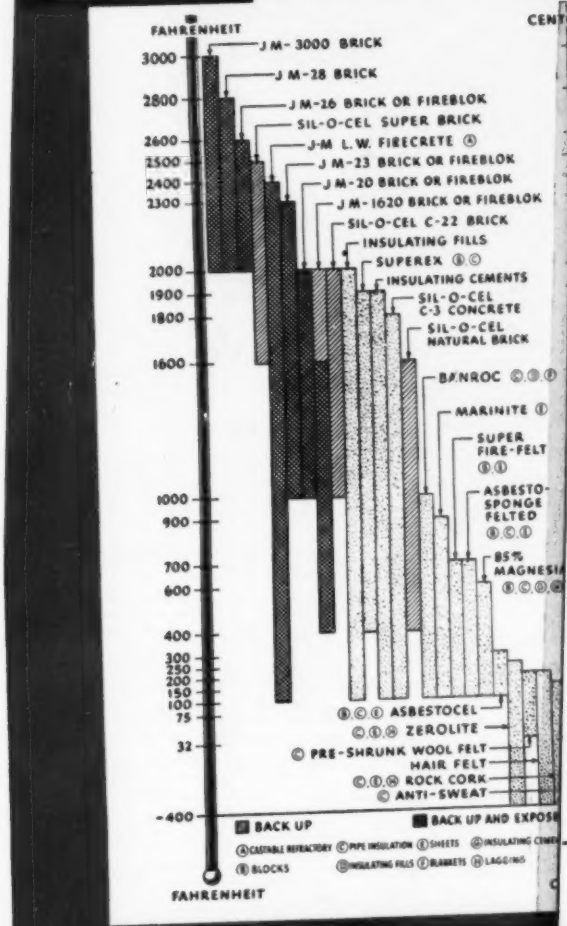
We are ready to assist you in its evaluation for your particular filtering operation.

ATTAPULGUS CLAY COMPANY

Dept. W, 210 West Washington Square, Phila. 5, Pa.

Ready reference chart...

Johns-Manville THERMAL INSULATIONS



FOR EVERY TEMPERATURE JM EVERY

Yours... for better insulation service!

Now, you can see at a glance the recommended insulation for every temperature range, from minus 400F to plus 3000F.

It's all on this convenient Johns-Manville Thermal Insulation Chart (11½" x 18") available for hanging in your office or on your plant wall.

Each insulation in this group of Johns-Manville products is tailor-made to do a specific type of job *best.* And, as part of the Johns-Manville Insulation Service, specialists are available to help you with present insulation problems . . . or with those connected with future plans.

By having these men select and apply Johns-Manville insulations, you will be dealing with men who have grown up in the business. You'll find that it will pay, in the long run, to have these experts help you... *because they have to their credit more man-hours of insulation application experience than all other similar types of organizations combined.*

For your copy of this chart, just fill in and mail the coupon below.

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Box 290
New York 16, N. Y.

Please send me copy of Johns-Manville Insulation Chart IN-6D.

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Title_____

Company_____

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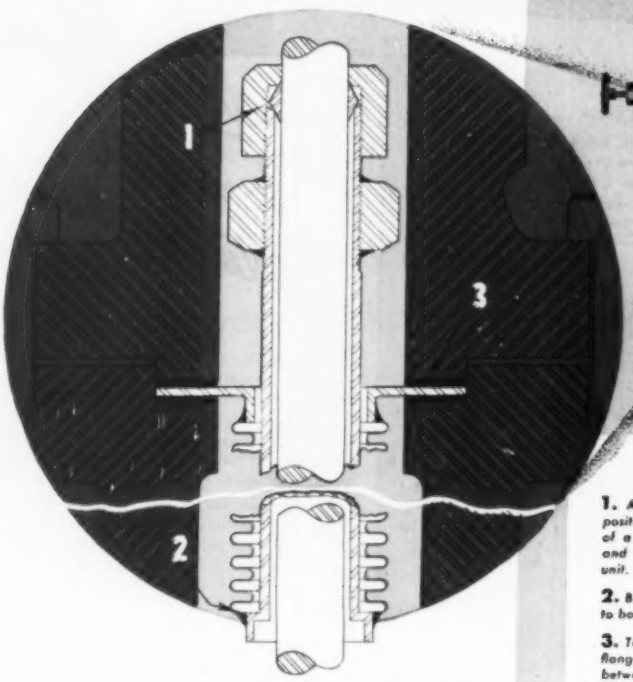
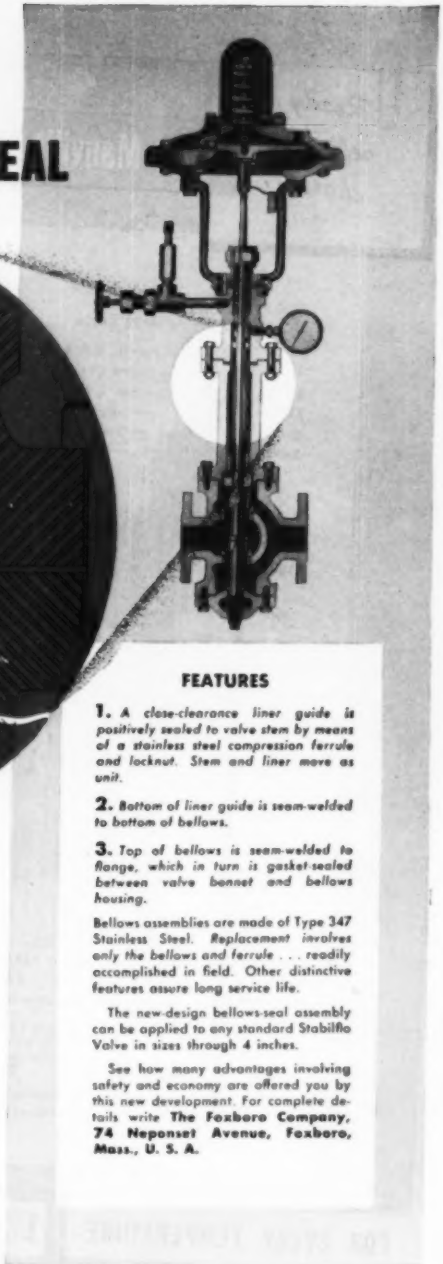
NOW! Stabilflo Valves with NEW, POSITIVE BELLOWS-SEAL





● Here's an automatic process control valve with a positive, safe, yet *simply-constructed* seal . . . for use wherever toxic, corrosive or precious fluids are involved. The Foxboro Stabilflo Valve is now available with a new-design, bellows-sealed valve stem. Instead of the conventional stuffing box, the packless bellows assembly makes a positive seal between the valve stem and valve body. The bellows expands and contracts with reciprocating action of valve stem.

Over the past eight years, Foxboro has pioneered in the development and application of bellows-sealed control valves for *special* jobs. This improved design is the outcome! It removes bellows-sealed valves from the class of "specials" because of its unique simplicity.

FEATURES

1. *A close-clearance liner guide is positively sealed to valve stem by means of a stainless steel compression ferrule and locknut. Stem and liner move as unit.*

2. *Bottom of liner guide is seam-welded to bottom of bellows.*

3. *Top of bellows is seam-welded to flange, which in turn is gasket-sealed between valve bonnet and bellows housing.*

Bellows assemblies are made of Type 347 Stainless Steel. *Replacement involves only the bellows and ferrule . . . readily accomplished in field.* Other distinctive features assure long service life.

The new-design bellows-seal assembly can be applied to any standard Stabilflo Valve in sizes through 4 inches.

See how many advantages involving safety and economy are offered you by this new development. For complete details write **The Foxboro Company, 74 Neponset Avenue, Foxboro, Mass., U. S. A.**

FOXBORO REG. U. S. PAT. OFF. **INSTRUMENTATION**

Keeping stainless steel STAINLESS

. . . a typical problem in fabricating alloy piping

Heat a piece of stainless steel pipe to bend it and right away you're up to your ears in metallurgical complications. To begin with, stainless steel isn't just one alloy. There are hundreds of different types of stainless steel, each selected for its resistance to corrosion or its stability at high temperatures. To maintain the metallurgical properties which dictate the choice of a particular alloy steel, you have to know the temperature range within which this steel may suffer excessive metallurgical changes. And you have to have specialized equipment to maintain the precise control necessary to avoid these hazards.

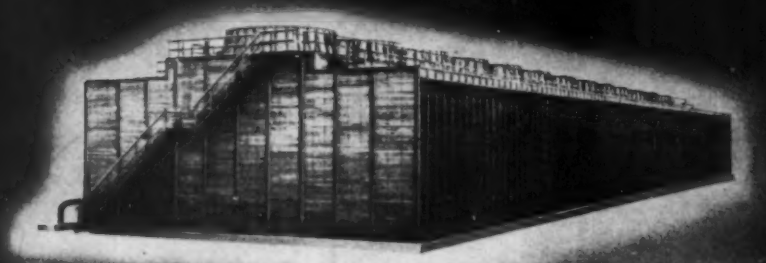
Grinnell pipe fabrication equipment includes specially designed gas-fired radiant heat furnaces for this precisely controlled heat treatment of stainless steels and other alloy steels. Multiple burners are strategically located to distribute temperature uniformly and to prevent harmful flame impingement. Precision instruments regulate temperature and time.

It's an intricate business . . . fabricating alloy steel piping. It's a job for Grinnell prefabricating plants because Grinnell has the equipment and modern methods, the interpretive engineering, the metallurgical research facilities and the skilled personnel.

GRINNELL

Grinnell Company, Inc., Providence 1, Rhode Island. Branches: Atlanta • Buffalo • Charlotte • Chicago • Cleveland • Cranston • Fresno • Kansas City • Houston
Long Beach • Los Angeles • Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

Specify MARLEY Double-Flow



FOR AN ENGINEERED TOWER STRUCTURE

Every Double-Flow Cooling Tower is structurally sound . . . able to give twenty-four hour a day, year around service.

Double-Flow cooling towers have been subjected, during the past decade, to hurricane, earthquake, corrosive atmosphere and other similar tests without suffering a single loss. Here's why:

LUMBER . . . only the finest HEART QUALITY REDWOOD is used. All structural members are properly sized and are free from sapwood that is subject to fungus and insect attack.

HARDWARE . . . heavy bolts are used throughout with ring connectors added at critical joints . . . no nails are used to bear any structural load.

MECHANICAL EQUIPMENT SUPPORT . . . massive, corrosion-free wood crossbeams are used to support the mechanical equipment. Diagonal bracing in this area gives added strength.

COLUMNS . . . vertical columns placed on a maximum of six foot centers. Louver posts are machined to accommodate the continual expanding and contracting slip-fit louvers.

BRACING . . . transverse and longitudinal bracing extending from each six foot height to the bottom of the tower.

Each joint and every detail, as well as the major members of a standard MARLEY DOUBLE-FLOW Cooling Tower are guaranteed against a 30-pound wind. The low, wide design of the Double-Flow gives unusual stability.

To be sure YOUR new cooling tower is STRUCTURALLY SOUND, Specify MARLEY DOUBLE-FLOW!

Ask for a Marley Factory-Trained APPLICATION ENGINEER to tell you more about the MARLEY-DOUBLE-FLOW and its ENGINEERED STRUCTURE. He'll be glad to help you solve your water cooling problems. No cost or obligation.

MARLEY COOLING TOWERS

THE MARLEY COMPANY, INC. • KANSAS CITY 15, KANSAS

To insure the efficiency of operation intended in the original design

NOTHING EQUALS STAINLESS STEEL

A STAINLESS STEEL of the U·S·S 12 type was used by the A. O. Smith Corporation, Milwaukee, in this ¾" lining for a giant fractionating tower, 116 ft. long by 16 ft. in diameter, recently built for a Chicago area refinery.

Here is a typical application of U·S·S Stainless which, by lengthening the on-stream periods and speeding up turn-around time, fully justifies its selection.

U·S·S Stainless Steels are available in a wide variety of analyses to meet practically any requirement of oil refinery service. But it is well to remember that these steels have different physical characteristics which must be thoroughly understood if Stainless is to give optimum results both in fabrication and in on-the-job performance. For that reason, expert advice on the selection and on the fabricating methods employed is vitally important. This we are prepared to furnish.

Our Stainless engineers are specialists in the use of Stainless Steel. Ask for their co-operation. You'll find their suggestions practical and extremely helpful not only in determining what grade of U·S·S Stainless will do the best job for you, but in showing how it can be handled most efficiently through the fabricating shop.

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO · CARNEGIE-ILLINOIS STEEL CORPORATION, PITTSBURGH & CHICAGO
COLUMBIA STEEL COMPANY, SAN FRANCISCO · NATIONAL TUBE COMPANY, PITTSBURGH · TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

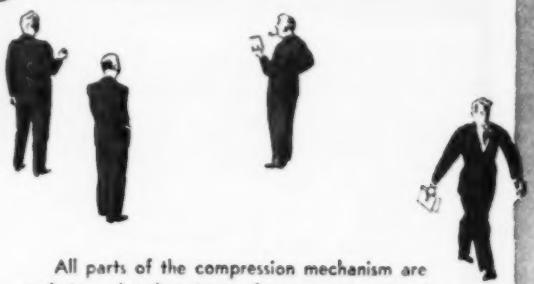
8-1007

UNITED STATES STEEL

NEW! POSITIVE-SEAL

IN VOGT TWO-PASS SHELL HEAT

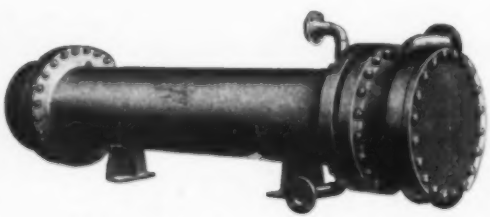
VOGT ENGINEERS SOLVE NUMBER ONE HEAT EXCHANGER PROBLEM



How to provide an absolutely tight seal for the longitudinal baffle in two-pass shell heat exchanger construction has long been the concern of heat transfer equipment builders but its attainment has eluded them until now. Today, the Vogt Positive-Seal Two-Pass Baffle described and illustrated here, operates with high efficiency in units serving many industries.

BAFFLE CONSTRUCTION

The baffle consists of a solid plate, inserted between the tube sheets of the tube bundle, having outwardly opening channels on each side. After inserting the tube bundle in the shell, there is loosely placed in each channel, and in the order named, a compression mechanism composed of a longitudinal series of pivotally connected steel links, a steel backing strip, and a suitable packing.



This two-pass shell Solution Cooler is equipped with the Vogt pivoted-link baffle sealing mechanism.

All parts of the compression mechanism are cadmium plated to insure free operation at all times.

SEALING THE BAFFLE

To seal the baffle, after the bundle is in position and prior to bolting on the cover of the unit, it is only necessary to turn the nut of the compression screw on the end of the compression linkage so that it bears against the locking washer. A stop in the other end of the baffle channel forces the adjacent end of the linkage, as well as the intermediate links, in a toggle-like action outwardly against the backing strip. Each link adjusts itself individually to transmit equal pressure along the length of the packing as it conforms to any unevenness of the shell. To remove the bundle from the shell, the seal is broken by backing off the compression nut whereby the linkage is retracted and pressure is removed from the packing.

Vogt Two-Pass Shell Exchangers are used in all services where overlapping temperatures ordinarily require two single pass shells.

HENRY VOGT MACHINE CO.

Louisville 10, Kentucky

BRANCH OFFICES:

NEW YORK • PHILADELPHIA • CLEVELAND

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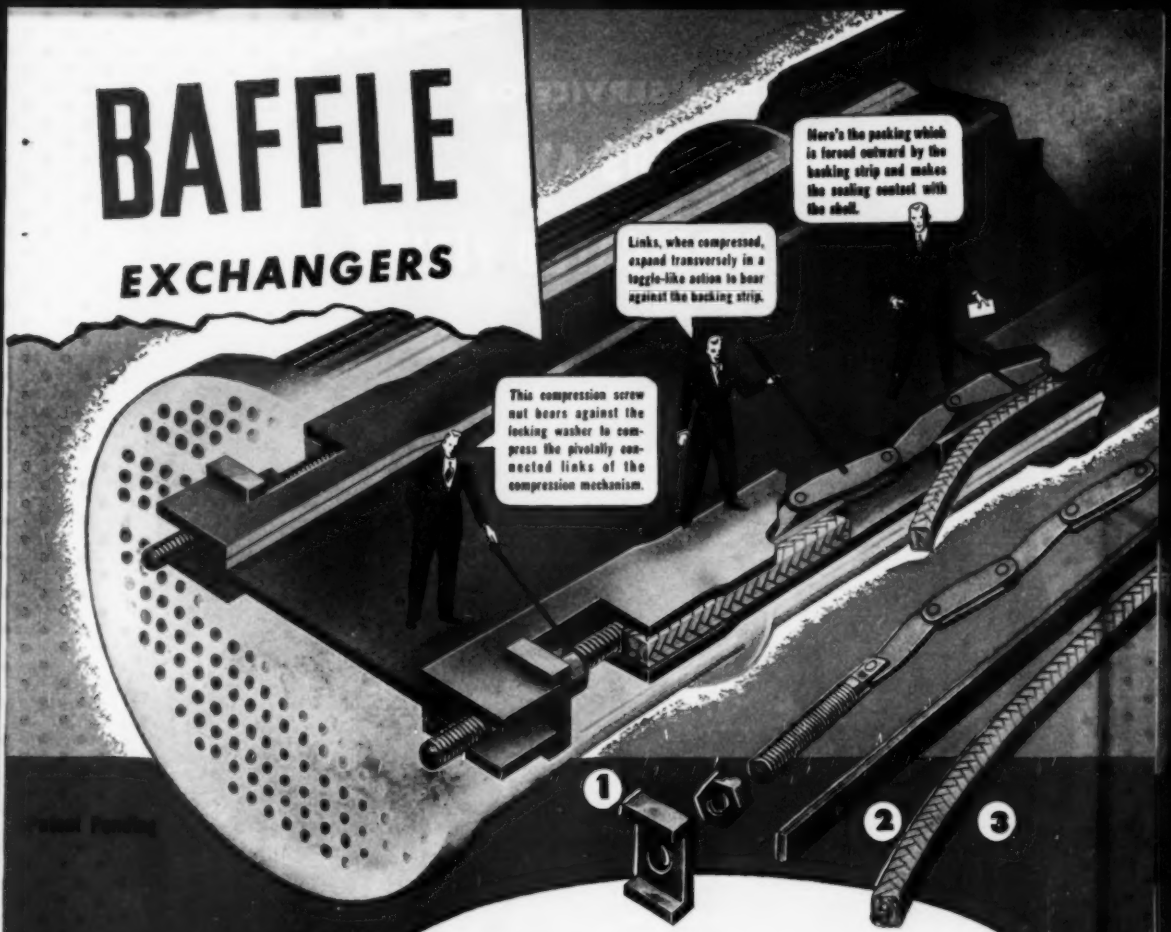
DALLAS

BAFFLE

EXCHANGERS


Here's the packing which is forced outward by the backing strip and makes the sealing contact with the shell.
Links, when compressed, expand transversely in a toggle-like action to bear against the backing strip.
This compression screw nut bears against the locking washer to compress the pivotally connected links of the compression mechanism.
1
2
3

1 Exploded view of locking washer, compression nut, and screw attached to compression linkage.

2 Steel backing strip which equalizes pressure against packing.

3 Packing which makes the seal between baffle and shell.

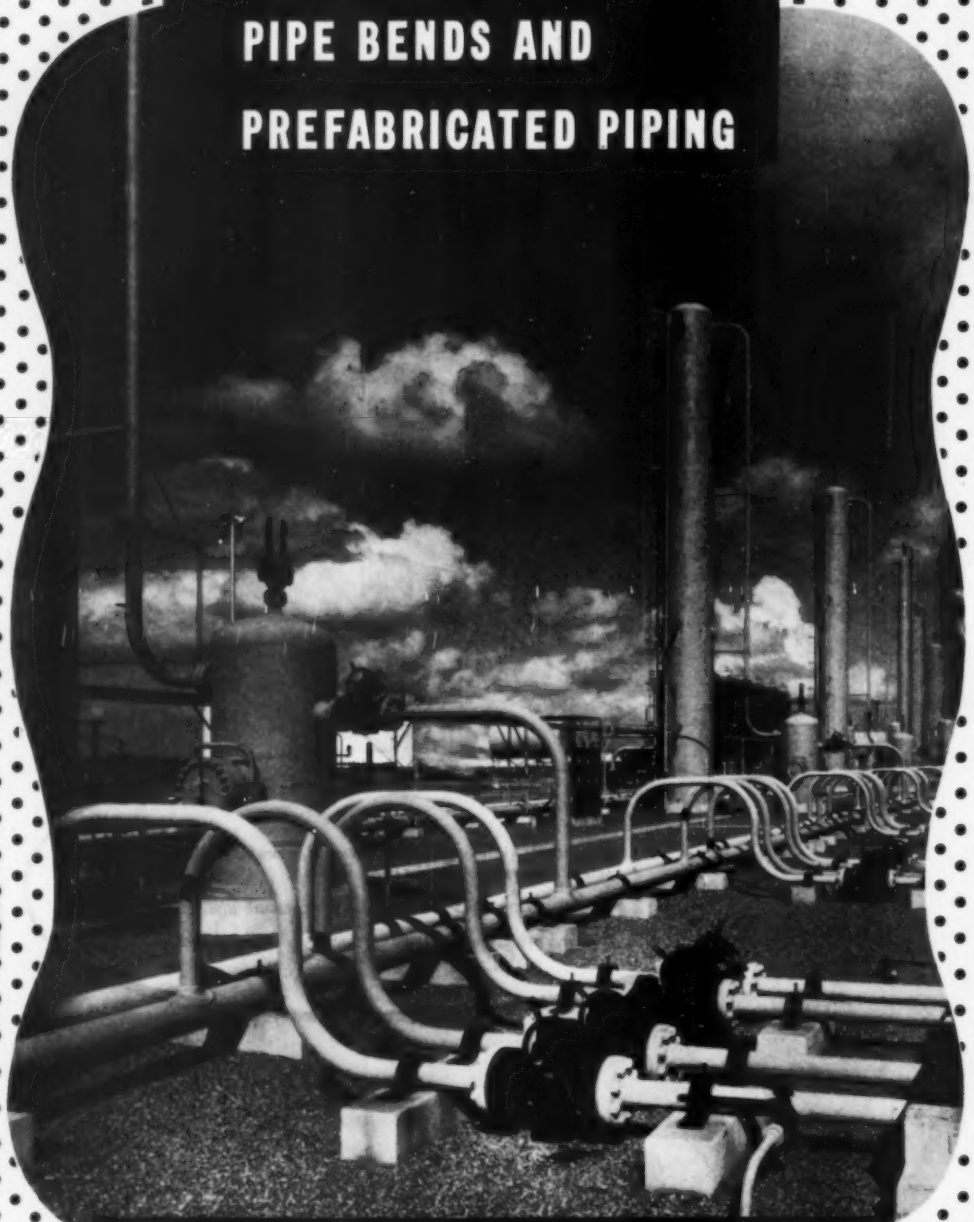
Vogt

POSITIVE-SEAL U-TUBE PASS

HEAT EXCHANGERS

DEPENDABLE SERVICE ON

PIPE BENDS AND PREFABRICATED PIPING



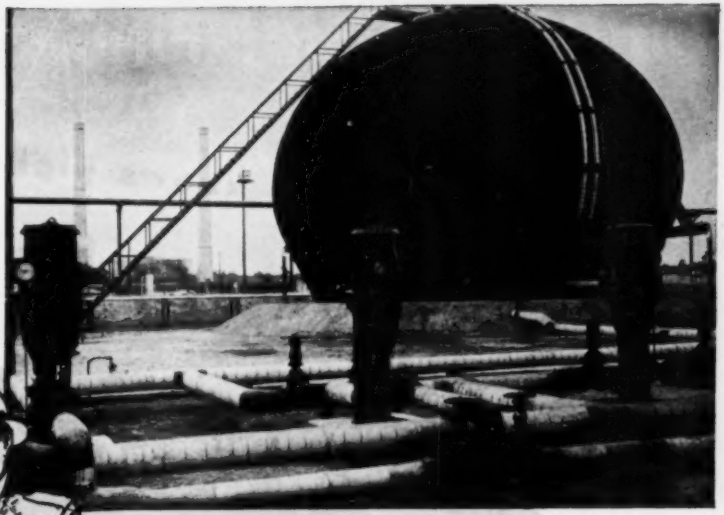
TEXAS PIPE BENDING COMPANY

PIPE BENDS
PIPE COILS
WELDED HEADERS

Pipe Fabricators
HOUSTON TEXAS

OFFICE AND PLANT
301 FRIO STREET
WOODCREST-6-2659

Taking suction from a vessel set at ground level. Three of a large group of VMT Pumps used for feeding, charging, extracting, returning, and transferring acetane, butane, and butadiene.



B.J.

are you getting your share of specialized engineering?

with pumps for ... low NPSH requirements? ... limited space locations? ... hot and cold fluids? ... corrosive fluids?

As early as 1912, oil company engineers recognized the part Byron Jackson had played in the development of centrifugal pumps. If not the first, Byron Jackson Co., was one of the earliest manufacturers to build a line of centrifugal pumps in anything approaching a good range of types and sizes.

ONE OF MANY OUTSTANDING DEVELOPMENTS, Byron Jackson VMT type are vertical pumps specially designed for limited space locations and pumping jobs where the net positive suction head is limited. These pumps save you the cost of raising vessels or excavating elaborate pits. VMT Pumps take suction from the barrel in which the pumping unit is located. The small pump-base of a VMT is at ground level. The length of the barrel is determined by the NPSH requirement.

Standardized in four barrel sizes ... 8, 10, 12, and 14 inches ... the VMT Pumps are available in capacities to 1000 gpm at heads up to 250 psi, and at fluid temperatures to 250°. On special orders capacities to 5000 gpm are available. All sizes, with special materials, are available for corrosive fluids, and for temperatures from sub-zero to 750° F.

For condensate service. This is a 24", 4-stage VMT Pump with a 75 hp, 900 rpm motor. This installation pumps 2000 gpm against a total head of 120'.

Byron Jackson Co.

Since 1872

LOS ANGELES 54, CALIFORNIA

Offices in Principal Cities

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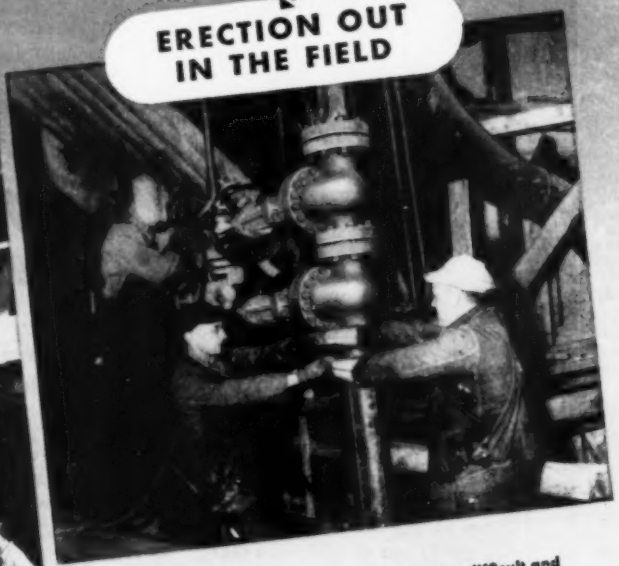
YOU GET BETTER PIPING

because MIDWEST knows piping problems

INSIDE and OUT

PREFABRICATION IN THE SHOP

ERECTION OUT IN THE FIELD



Because Midwest has erected some of the most difficult and exacting piping jobs out in the field, in addition to having prefabricated them in the shops, we have a clear, competent view of piping problems from every angle.

Our Fabricating Department works closely with the Contracting Department . . . continually seeking ways of making their job easier, less costly, and higher in quality. The Contracting Department is always ready to make practical suggestions for improving prefabricated piping subassemblies. It is in constant and intimate touch with piping users in all types of industry. Changes in needs—changes in thinking are quickly relayed to the whole Midwest organization.

The net result to you is better piping whether you want a simple pipe bend . . . a series of complex prefabricated subassemblies . . . or a difficult piping job completely erected.

MIDWEST PIPING SERVICE IS NATION-WIDE

4 PLANTS ARE BETTER THAN 1

PIPING FABRICATORS AND CONTRACTORS

MIDWEST PIPING & SUPPLY COMPANY, INC.

Main Office: 1450 South Second Street, St. Louis 4, Mo.

Plants: St. Louis, Passaic, Los Angeles and South Boston

Sales Offices: New York 7—30 Church St. • Chicago 3—79 West Monroe St.
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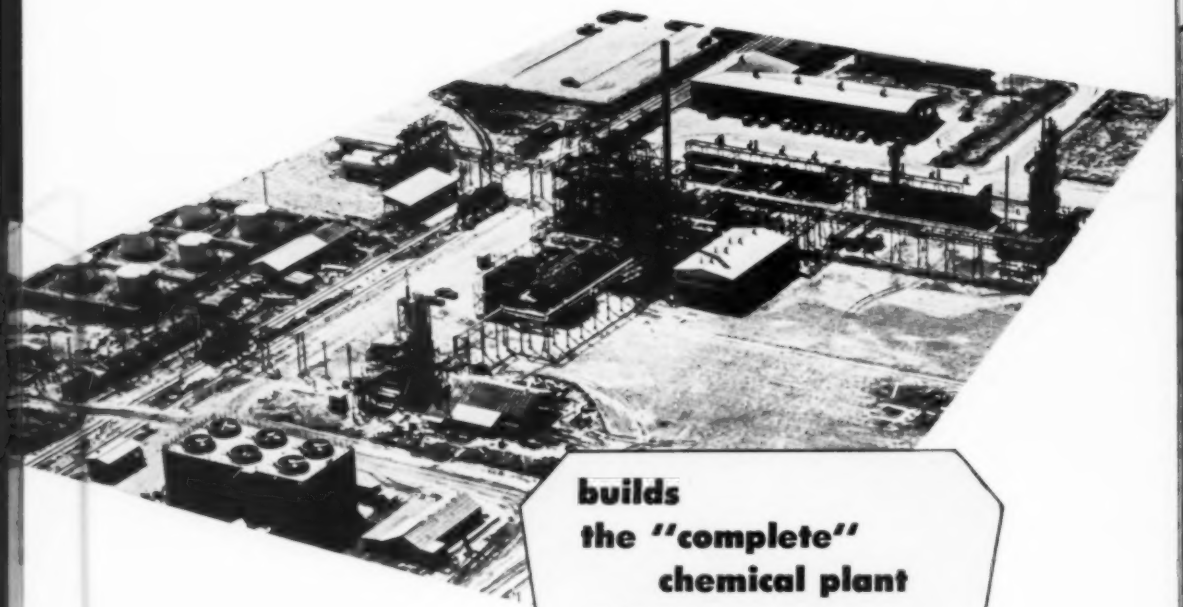
engineering projection - - - into *Plexiglas*

Producing "Plexiglas intermediates", products of a new catalytic synthesis process, this complete chemical plant represents the collaboration of the Rohm & Haas Company who supplied the basic process design data, and the Foster Wheeler Corporation who provided mechanical design, engineering, and construction.

FOSTER WHEELER CORPORATION

165 BROADWAY NEW YORK 6, NEW YORK

the "complete" engineering service . . .



builds
the "complete"
chemical plant

plant layout . . foundations . . sewerage
tankage . . buildings . . roadways
instrumentation . . airheaters . . exchangers
watercooling and distribution
3 chemical process units
Hypersorption unit

Plus . . mechanical design . . drafting . .
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. . . and representing an excellent example of Foster Wheeler's complete engineering service to industry . . . in office, shop, and field.

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WeldELLS *have everything...*

Why that smile on Joe?

Joe may not know much about the engineered strength of WeldELLS, or the metallurgical control, or the greater scope of the WeldELL line. However, it is plain enough that these considerations which mean so much to you begin to lose meaning unless Joe does *his* part of the job right.

That's why we designed WeldELLS, not only for you, but also for Joe. That's why Joe smiles: A good Welder like Joe takes extra pride in the kind of job he can turn out when it's made easy for him by these easily identified fittings, with sized end tangents, cleanly machined bevels, precision quarter markings to speed lining up, accurate key dimensions, plus other conveniences that are combined only in WeldELLS.

Yes, Joe does a better job with WeldELLS . . . and in the final analysis, *your* work rests on Joe's work!

Remember that the line which offers the most to both you and Joe, also contains the most complete range of sizes, thicknesses, and types of fittings, *and* in a complete range of materials. Convenient stocks are carried in all industrial centers.

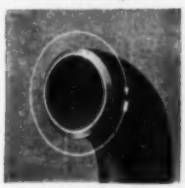
Note these features that appeal to the man on the job:

No guess-work; markings clear and complete.

Precision quarter marks mean a lot to the welder.

Extreme accuracy, uniformly maintained.

Sized end tangents.



Cleanly machined bevels.

TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS General Offices & Works: Chicago 90, Ill. (P.O. Box 485). Eastern Plant: Carnegie, Pa. Western Plant: Fontana, Calif. • District Offices—New York: 50 Church Street • Philadelphia: Broad Street Station Bldg. • Pittsburgh: First National Bank Bldg. • Chicago District Sales: 208 S. LaSalle Street • Houston: City National Bank Bldg. • Los Angeles: Subway Terminal Bldg.

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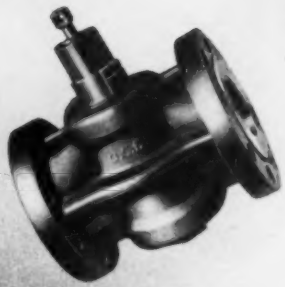
Cylindrical Plug gives full volume pipe flow

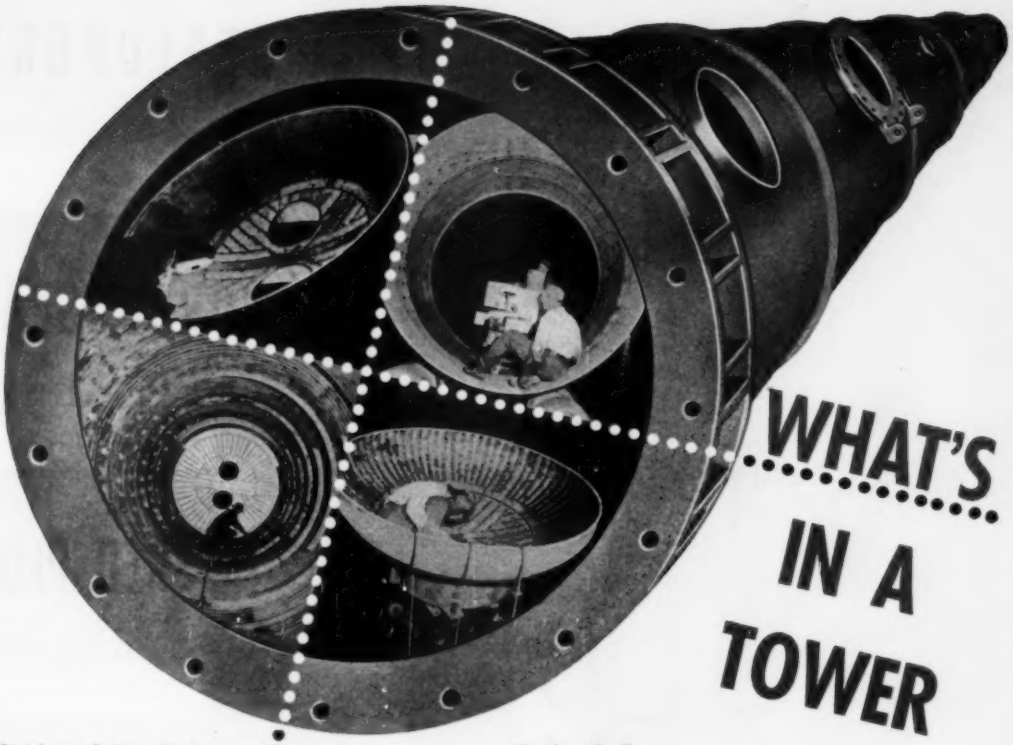


a.c.f. Cylindrical Plug Valves cut the man-waiting time of flow control in batch measuring. And on high volume flow, the exclusive straight-through, full pipe opening saves power. Any valve less efficient is more costly in the long run.

CYLINDRICAL a.c.f. FULL PIPE AREA LUBRICATED **PLUG VALVES**

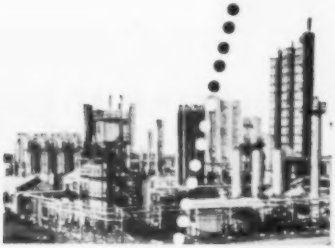
Representatives in more than 50 principal cities.

Write for catalog 3-PR showing types and sizes American Car and Foundry Company, Valve Division, 30 Church Street, New York 8, N. Y.



WHAT'S IN A TOWER

Fluid catalytic unit tower 8'0" ID x 50'0" 5/8" steel shell, clad with 12 gauge stainless steel strips, complete with tray supports...Nooter fabricated to Universal Oil Products Co. design.



besides design and metal?

Well, for one thing: Over one mile of Nooter *DuraPure* Welding. The continuous automatic and manual arc-welded construction surpasses API-ASME Code specifications. . . Uniform bond achieves high strength, and surface purity of welds maintains corrosion-resistance. Stress-relieving insures safety and precise, undistorted alignment.

After being cross-checked for precision fit-up the vessel was shipped on schedule — ready for erection.

This is why Nooter-fabricated equipment is competently serving the petroleum industry throughout the world.

When your blue prints are ready — call in Nooter!

NOOTER

Nooter Catalog, complete with corrosion data charts is sent at your request.

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Effective valving

SEALDPORT.

NORDCOSEAL.

TAPERED PLUG.

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Nordstrom valves cost less in terms of service rendered

NORDSTROM VALVE DIVISION *Rockwell Manufacturing Company*
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Atlanta, Boston, Chicago, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa . . . and leading Supply Houses

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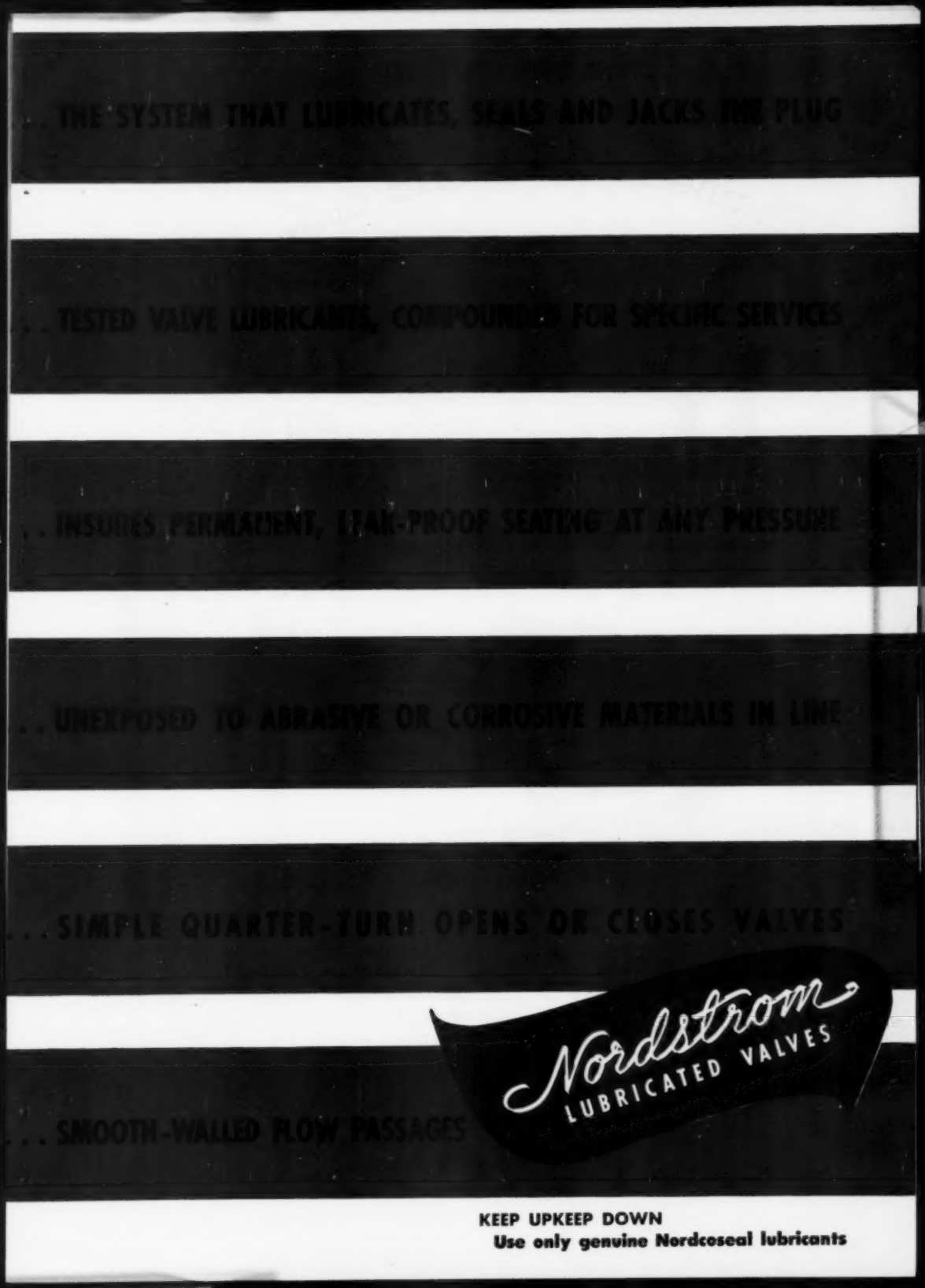
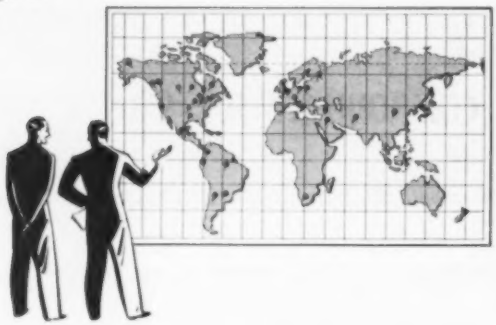

. . THE SYSTEM THAT LUBRICATES, SEALS AND JACKS THE PLUG
. . TESTED VALVE LUBRICANTS, COMPOUNDED FOR SPECIFIC SERVICES
. . INSURES PERMANENT, LEAK-PROOF SEATING AT ANY PRESSURE
. . UNEXPOSED TO ABRASIVE OR CORROSIVE MATERIALS IN LINE
. . . SIMPLE QUARTER-TURN OPENS OR CLOSES VALVES
Nordstrom
LUBRICATED VALVES
. . . SMOOTH-WALLED FLOW PASSAGES
KEEP UPKEEP DOWN
Use only genuine Nordcoseal lubricants

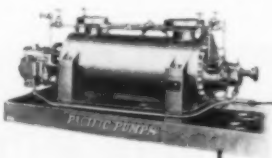
FOR THE BEST IN
PRODUCTS AND SERVICE

Engineers the World over specify

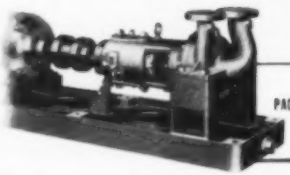
PACIFIC *Precision Built* PUMPS



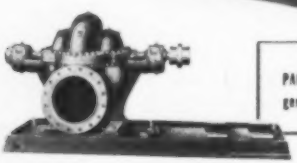
Engineered to the service requirements
Hydraulically designed for sustained efficiency
Mechanically designed for endurance and simplicity



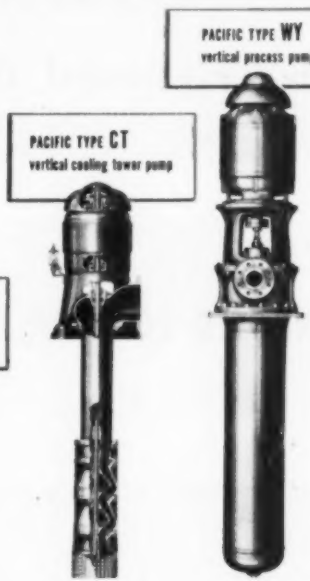
PACIFIC TYPE **I**
hot charge pump



PACIFIC TYPE **SVC**
process pump



PACIFIC TYPE **DC**
general service pump



PACIFIC TYPE **WY**
vertical process pump

PACIFIC TYPE **CT**
vertical cooling tower pump

Pacific builds a complete line of Vertical and Horizontal Single and Multi-stage Pumps in all capacities, pressures and temperatures

25 YEARS

PACIFIC *Precision Built* **PUMPS**

PACIFIC PUMPS INC. HUNTINGTON PARK, CALIFORNIA
One of the Dresser Industries
Export Office: Chanin Bldg., 122 E 42nd St., New York
Offices in All Principal Cities

C-1

1 First step in this installation of Kaylo Heat Insulating Block is the welding of long Nelson Insulation Pins to the surface. Section of a large dryer is shown here.

2 Block is then impaled on the pins and pushed against the metal surface. Two layers are being applied. Workman here applies first layer; "Speed Clips" over second layer anchor both layers in place.

3 Kaylo Heat Insulating Block is available in standard block sizes. Where special shapes are needed, the block can be easily cut to fit with ordinary hand or power tools.

KAYLO HEAT INSULATING BLOCK

Remarkable advantages combined in one material

4 Final step is cutting off projecting ends of insulation pins as shown. (A cement finish may be applied over the block and troweled smooth.)

5 When completed, this dryer will have the best in heat insulation—Kaylo Heat Insulating Block . . . lightweight, strong, highly efficient and easy to install.

KAYLO Heat Insulating Block combines those outstanding advantages that almost every user of heat insulating block is seeking—light weight, strength, high efficiency and a wide temperature range—from ambient temperatures up to 1200° F.

This new insulation is a lightweight mineral product, efficient through the whole temperature range for which it is recommended. It is strong enough to bear the weight of workmen walking on it or ladders leaned against it. It is less fragile and less subject to abrasion than most insulating blocks—less affected by moisture or occasional wetting.

KAYLO®
Heat Insulating Block

AMERICAN STRUCTURAL PRODUCTS COMPANY
Subsidiary of
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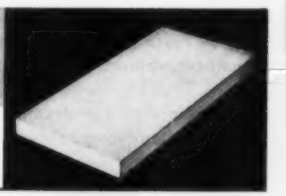

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Gentlemen:

Please send: ☐ Free illustrated booklet, "Kaylo Heat Insulating Block."
☐ Free sample of Kaylo Heat Insulating Block.
☐ Your representative, with full information.

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UPGRADE

YOUR LEADED OCTANE RATING

6 TO 8 NUMBERS

WITH PERCO CYCLOVERSION

In many refineries, large and small, Perco Cycloversion units are improving the octane level of gasolines as *much as ten ASTM octane numbers with no significant volume loss!* Flexibility of this process permits each unit to be used as a desulfurizer, or as a catalytic reformer-desulfurizer. Operating cycles are long, eliminating costly control equipment. Operating conditions are mild. The rugged long-life catalyst provides substantial savings in operation.

A Perco engineer will gladly explain how this modern refinery method can benefit you by upgrading your total throughput to meet present market demand for higher octane number product.

PERCO PROCESSES

PROFIT WITH PERCO PROCESSES

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Here's a valve that NEVER STICKS, because

it's Lever-Seald

HOMESTEAD LEVER-SEALD VALVES operate freely and effectively in services where temperature extremes, pressures and the corrosive action of line fluids cause ordinary valves to "stick" or "seize." Positive *stick-proof* action is assured by an exclusive built-in lever-and-screw device—operated by a quarter-turn of the lower lever—which relieves seating pressure just enough to overcome friction and permit a quarter-turn of the upper lever to the open or closed position. Seating pressure is again applied with the lower lever to provide a positive, leakless seal.

Further assurance of quick, easy operation is the fact that all HOMESTEAD LEVER-SEALD VALVE operating parts are protected from line contents in both the open and closed positions. Corrosion or erosion of valve seating surfaces is therefore reduced to a minimum.

You may order HOMESTEAD LEVER-SEALD VALVES in metals or alloys to suit your requirements in sizes 1½" to 10", for pressures from 150 to 1500 lbs. Write today for full information and copy of Section 3, Valve Reference Book No. 39.

Check THESE OUTSTANDING LEVER-SEALD VALVE FEATURES

1. Instant Stick-proof operation.
2. Quarter-turn fully opens or closes.
3. Positive seal without lubrication.
4. Seating surfaces always protected in both open and closed positions. Corrosion practically eliminated.
5. Unobstructed straight-line fluid flow.
6. All operating parts protected from damaging effects of service conditions and weather.

HOMESTEAD VALVE MANUFACTURING COMPANY

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CIRCULAR CHART POTENTIOMETER

Available with or without automatic standardization!

CONTINUED acceptance by industry leaders like these vouches for the quality and performance of the *ElectroniK* Potentiometer . . . the instrument that is built *up to a standard, not down to a price!*

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Here are the reasons why the Brown *ElectroniK* Potentiometer is the leader, and has been the leader since its introduction in 1941

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SENSIBLY PRICED . . made possible only by volume production.

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Advanced Instrumentation
FOR THE PETROLEUM INDUSTRY

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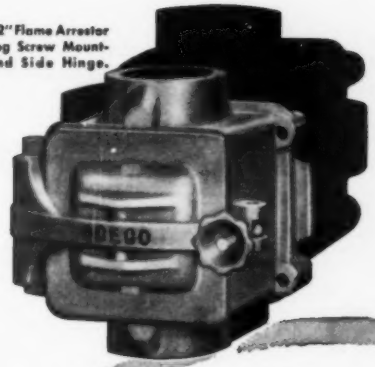
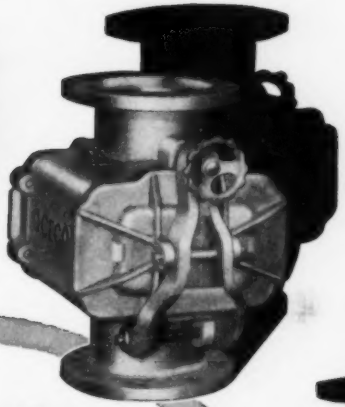


Oceco 2" Flame Arrestor Showing Screw Mounting and Side Hinge.



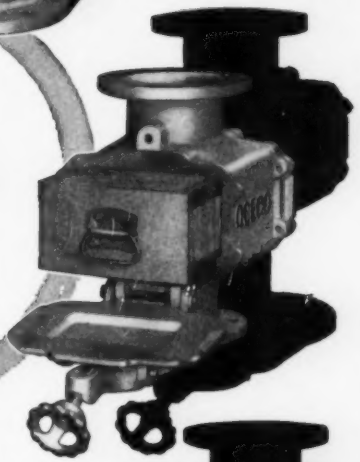
Oceco 6" Flame Arrestor Showing Flange Mounting and Bottom Hinge.

OCECO

FLAME ARRESTORS

for outstanding performance

Below — View of Oceco Type "F" Fixed Bank.



● Oceco Flame Arrestors—have won outstanding recognition throughout the entire petroleum industry. They combine the desired flame stoppage and explosion prevention with minimum pressure drop.

Housings and covers are semi-steel castings, with high melting point and consequently provide substantial heat resistance and protection to the flame arrestor "bank", even when subjected to the intense heat of sustained fire.

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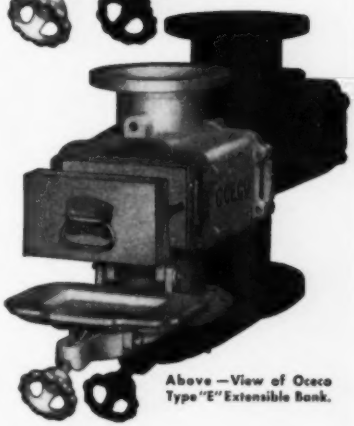

Above — View of Oceco Type "E" Extensible Bank.

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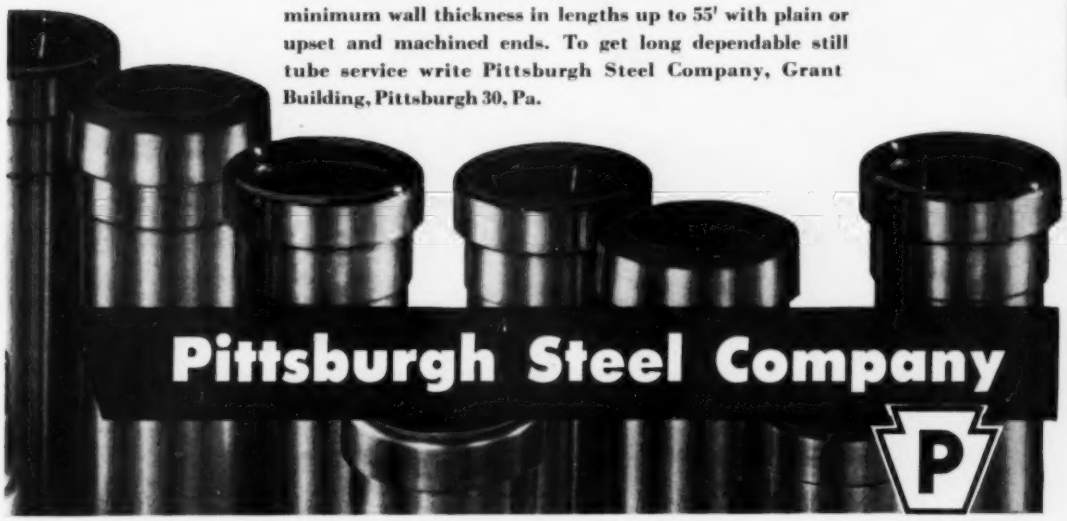

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CONTROL VALVES for every Process Application

There is a FLO-TESTED Hammel-Dahl Control Valve that will meet the exact requirements of every Process Control Application.

Engineered design for a maximum working pressure of 15,000 PSI and temperatures from —300° F. to 1200° F.

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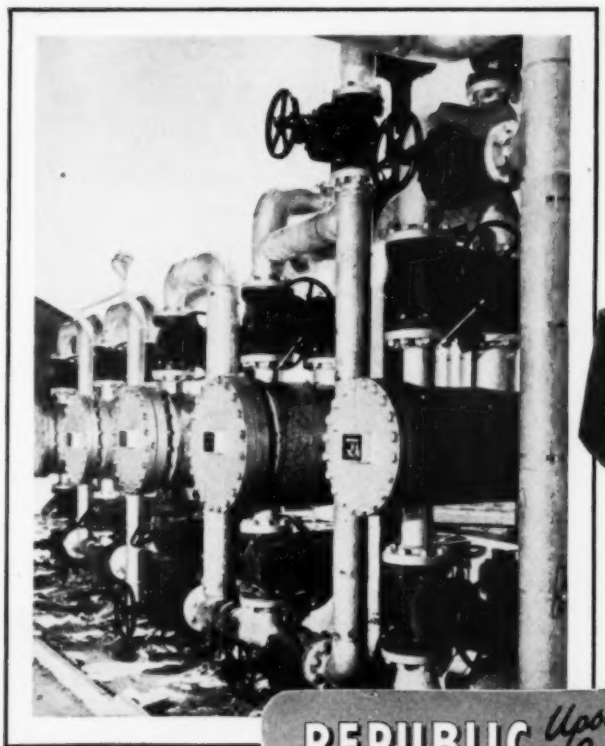

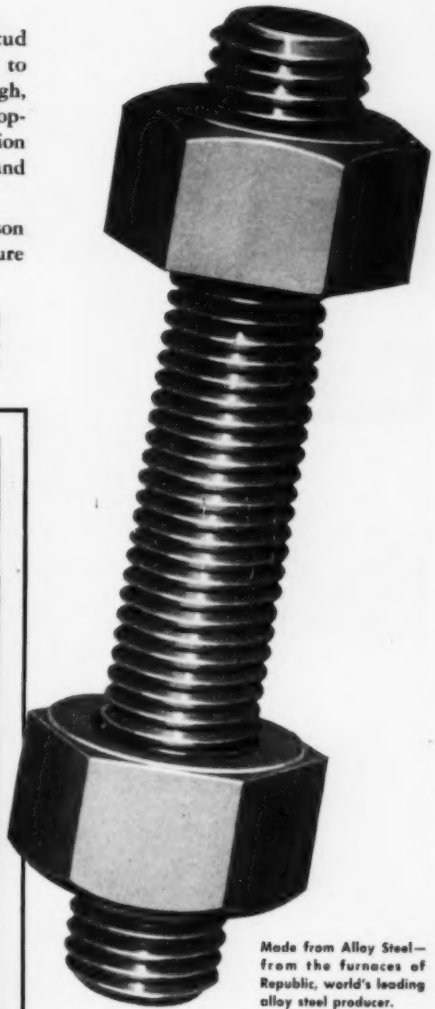

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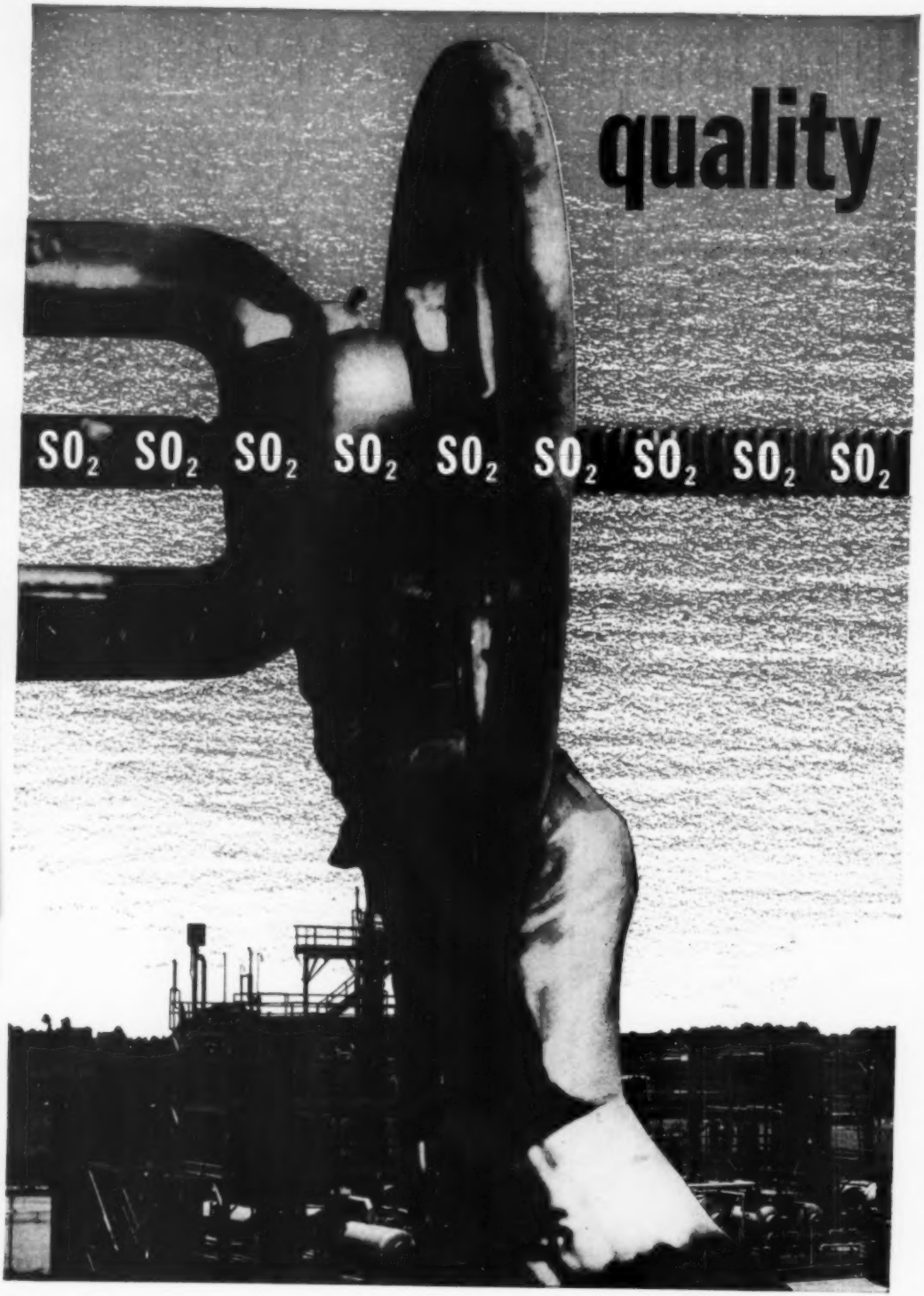
Other Republic Products Include Machine, Tank and Carriage Bolts—Lag Screws, Cap Screws and Rivets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Extraction by liquid sulphur dioxide provides the only solvent process which refines all fractions of mineral oils. First used for the production of high grade kerosenes, the Edeleanu process has been adapted by Badger to the refining of other distillates for new uses, including improved methods of producing pure aromatics, transformer oil and high cetane diesel fuels.

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This is another example of Badger's contributions to modern petroleum processing. The ability to originate and develop new ideas and to adapt proved methods to new problems is an integral part of Badger's service to the petroleum, chemical and petro-chemical industries.

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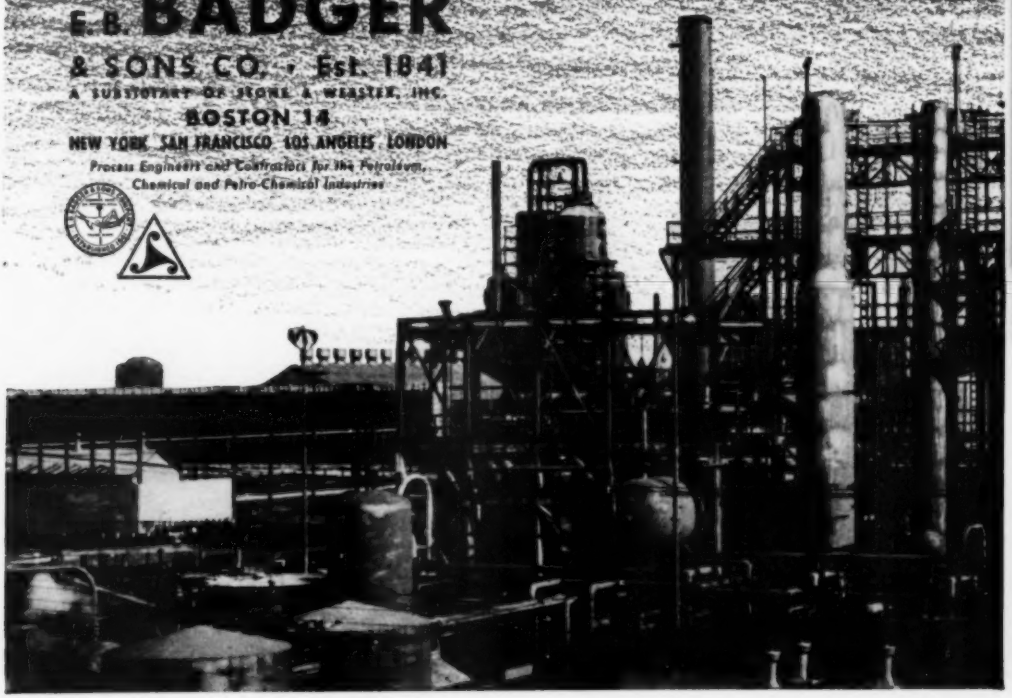
Process Engineers and Contractors for the Petroleum, Chemical and Petro-Chemical Industries



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You Are Cordially Invited To Submit Your Fabrication Problems To Our Engineering Department . . .
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Furfural

as a Selective Solvent

Furfural Solvent Refining Unit, photograph courtesy Sun Oil Company.

As a selective solvent furfural is producing high quality lube oils from a variety of crude stocks. The numerous installations here and abroad demonstrate the advantages of the operation, both technical and economic. Process information, engineering data, and test results on various oils are available from the licensor of the process.

Here are some facts about furfural itself useful in evaluating the solvent we supply.

1. **SAFETY**—Furfural is relatively non-toxic, hence introduces no unusual health hazard.
2. **FREEZING**—The low freezing point (−38°F) virtually eliminates danger of solidification in lines or equipment.
3. **STABILITY**—Furfural has extremely good heat stability [see *Ind. Eng. Chem.* **32,** *1639* (1940)]. This stability is emphasized by low operating losses in commercial units all over the world.
4. **COST**—A unique record of no increase in the price of furfural in over five years.
5. **SUPPLY**—Furfural is readily available from an unfailing source, for which nature creates abundant supplies of raw material each year.
6. **DENSITY**—A high density (1.160 at 68°F) plus low surface tension (49 dynes/cm. at 68°F) permits rapid phase separation.

Quaker Oats Bulletin 203—"Physical Data On Furfural"—contains comprehensive data, tables and curves on the physical characteristics of furfural. Obtain a copy from the nearest office listed below.

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Why? Because the editorial content has a dominating influence on advertising readership.

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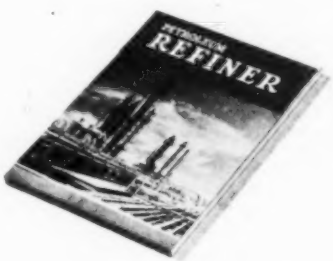
By delivering the editorial goods PETROLEUM REFINER assures you the consistent readership required for advertising results. It's the oil paper that does justice to your advertising message.



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● Unlike "bundle" type exchangers, which are custom built for a definite and fixed duty, Brown Fintube Sectional Hairpin Heat Exchangers give operating men almost unlimited flexibility to meet changing requirements. The capacity of the bank can be increased by adding additional sections to the original installation. Capacity can be decreased by valving off one or more of the parallel streams,—or reducing the number of sections in each stream. The entire bank can be changed from one duty, to another and totally different duty, by remanifolding the sections in different series-parallel arrangement. And the bank can even be disassembled, and the sections then reassembled as two or more smaller exchangers on different duties, in different plants.

Let us help you in adapting Brown Fintube Sectional Hairpin Heat Exchangers—with their many outstanding operating and maintenance advantages—to your next heat transfer requirement. The Brown Fintube Co., Elyria, Ohio. Sales engineers in the principal cities.

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HEAT EXCHANGERS

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2. Extreme Adaptability to Meet the Requirements of Changed Duties.
3. No Obsolescence.
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6. Minimum Investment in Replacement Parts.
7. The Brown Resistance Welded Integrally Bonded Fintube.
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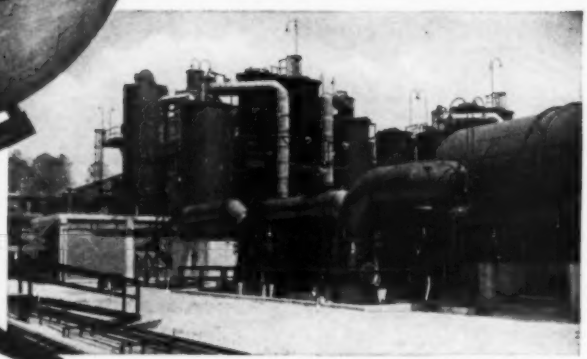

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when you "Turn on the heat"

Scaling due to oxidation at high temperatures is minimized, and tensile and creep strength are retained in service when your equipment is made of *ESCO* heat resisting alloy steels. Through years of use in petroleum refineries, chemical processing units and cement and ore treatment plants, these alloys have proved their stamina at temperatures up to and in some cases over 2000° F.

In addition to the standard alloys used for heat resistance, *ESCO* has both foundry and metallurgical facilities for producing special analyses for specific applications. Available also is the *ESCO* engineering staff, to assist in incorporating these alloys into practical, efficiently operating equipment that will minimize the problem of heat resistance in your plant.

For further information about *ESCO*'s metallurgical service, ask for catalog, "Stainless and High Alloy Steels in Process Equipment", which lists the various alloys and their physical properties. Get it from the *ESCO* office nearest you, or use the coupon below. Electric Steel Foundry, 2181 N. W. 25th Ave., Portland 10, Oregon. Offices in Eugene, Oregon; Chicago, Honolulu, Houston, Los Angeles, New York, San Francisco, Seattle, Spokane. In Canada, *ESCO* Limited, Vancouver, B. C.

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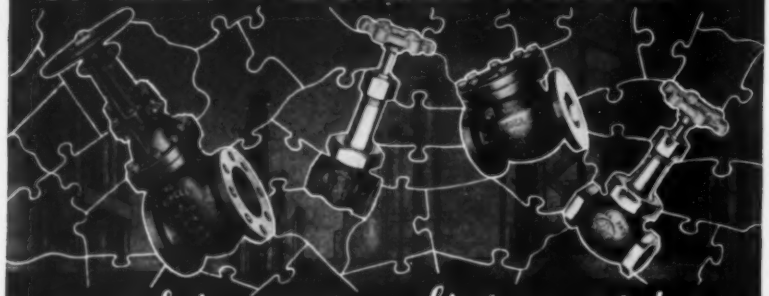
It takes POWELL VALVES *to complete your refining picture*



Naturally, to complete a jig-saw puzzle, you need all the pieces. And, for your complete oil refining picture you must have all the valves necessary to meet every existing flow control condition in your refinery.

Of course there are Powell Valves of standard design—in Bronze, Iron or Steel—for all the services for which these valves are adapted.

But modern refining processes have imposed many unusual demands. Powell meets them all with a *complete* line of High Pressure, High Temperature Valves* in special Alloy Steels and many Special Designs. These valves are especially adapted for service in making—

BUTADIENE — STYRENE — AVIATION GASOLINE — TOLUOL — BUTANE — BUTYLENE — ETHYLENE — PROPANE and other BASE PRODUCTS.

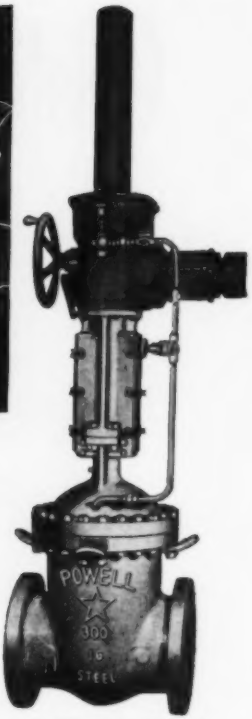


Fig. 3023—Class 300-pound Cast Alloy Steel Gate Valve with automatic steam sealing mechanism. Has explosion proof electric motor operator.

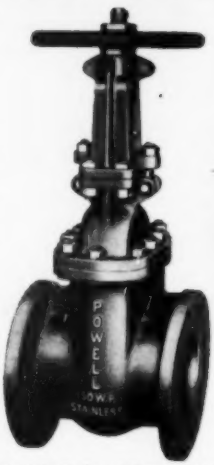


Fig. 2453-G—Large 150-pound Stainless Steel O. S. & Y. Gate Valve. Made in sizes 5" to 30", inclusive.

Fig. 1561 — Class 150-pound Cast Steel Swing Check Valve.

Fig. 1503 S. S. — Class 150-pound Stainless Steel O. S. & Y. Gate Valve.

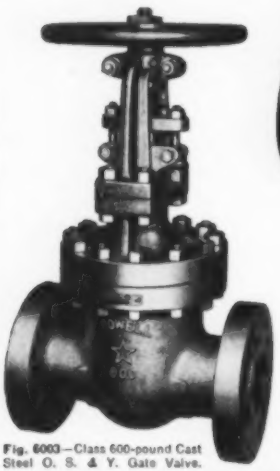


Fig. 6003—Class 600-pound Cast Steel O. S. & Y. Gate Valve.

*These valves can be made of various alloy steels, including corrosion-resisting and heat-resisting alloy steels; also with special trim parts. They are scientifically designed and have been especially built to handle the constantly increasing temperatures and pressures as well as the highly corrosive and erosive fluids encountered in the processing of hydrocarbons; to handle hydrogen chloride in isomerization and diisopropyl plants; hydrofluoric acid, sulphuric acid and sodium hydroxide in alkylation plants; for liquid and solid catalytic cracking; hydrogenation, dehydrogenation, hydroforming, polymerization, the regeneration of catalysts; for controlling flue gases and hydro carbons in transfer lines, and for handling sour crudes.

The Wm. Powell Co., Cincinnati 22, Ohio

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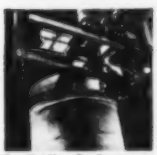
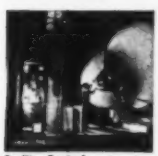
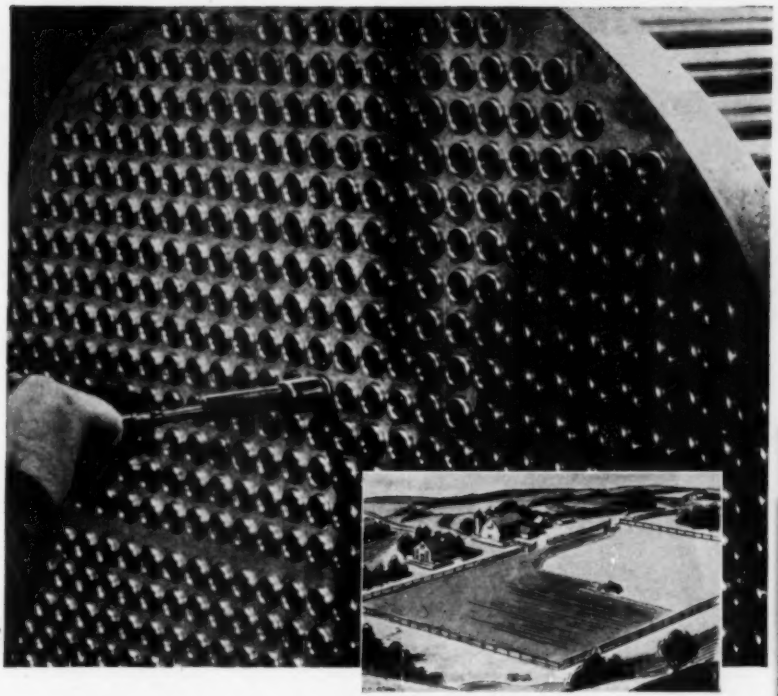


Top Welding Performance assured by specially designed equipment and exclusive employment of master operators.



Quality Control embracing the constant application of the most advanced inspection methods, both visual and non-destructive.

On-Time Delivery made possible by a flexible planning group authorized to re-route work to meet promised dates.



When an acre is small potatoes

ONE ACRE—43,560 square feet. It sounds like a lot of surface when talking about mowing a lawn. But it's "small potatoes" when you consider a recent Kellogg order for a quarter million square feet of heat exchanger surface—more than five acres. Another on the books for better than 200,000 square feet and yet another for 190,000 square feet.

That acre isn't so impressive now. But don't just consider the size of these orders. Think what orders of this magnitude imply.

Any group of heat exchangers for a normal refinery reaching such total transfer area would of necessity include all types for all refinery uses. Thus specialization as to size or application can't be the reason why Kellogg gets these tremendous orders. Price could be a determining factor but here again the modern refiner knows that the real economy in heat exchangers is found in high performance and low maintenance.

No, it is a lot more basic than price or type specialization. We like to believe that these orders result from two things: The acceptance of The M. W. Kellogg Company as outstanding in the technical advancement of the science of heat exchange itself, and twenty-five years of experience in manufacturing techniques that give Kellogg heat exchangers an appreciable advantage in lower maintenance cost.

It is the continuing research into better methods of transferring heat and the continuous development of better manufacturing techniques that creates this overall acceptance of M. W. Kellogg products.

To master temperature, pressure and chemicals use

M. W. KELLOGG

process equipment

VESSELS • EXCHANGERS • CONDENSERS • HIGH PRESSURE AND HIGH TEMPERATURE POWER PIPING PROCESS PIPING • FORGED AND WELDED FITTINGS . . . IN ALL STEELS, ALLOYS OR SPECIAL COMBINATIONS

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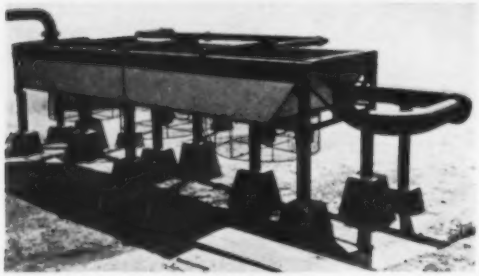
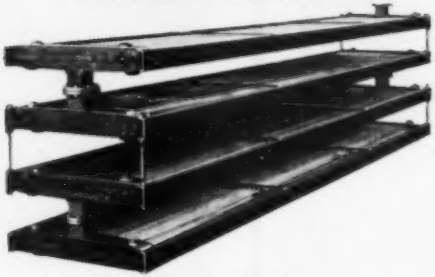
FIN-FAN EXCHANGER



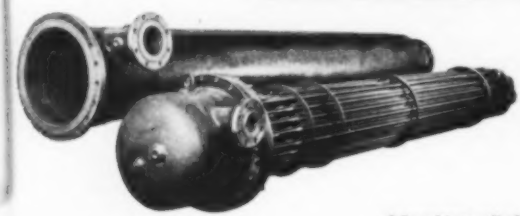
A "package type" air-cooled condenser or cooler that can be installed on the ground, within a building, or on a roof, and operates independently of the direction or velocity of surrounding air currents. Upper illustration: small FIN-FAN installation operating out-doors. Lower illustration: G-R K-FIN Air-Cooled Section which provides the FIN-FAN heat transfer surface. Described in Bulletin 1231.

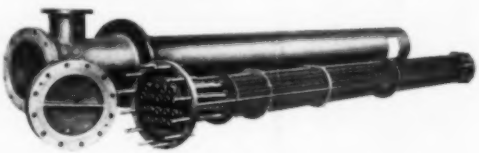
BENTUBE SECTIONS



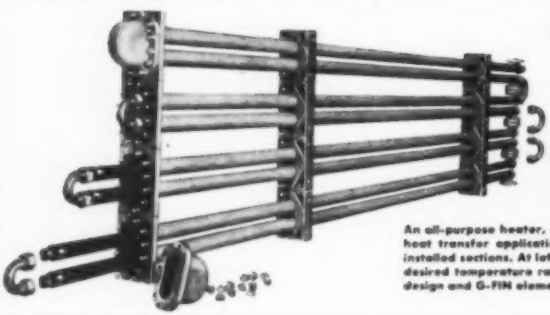
Atmospheric or submerged cooling or condensing sections with scale-shedding feature that eliminates the need for hand-scaling. Used by more than 400 refineries and natural gasoline companies. Upper illustration: stack of Bentube Sections. Lower illustration: top view of Bentube Section showing cold curvature of the Bentube elements. Described in Bulletin 1602.

G-FIN STORAGE TANK OIL HEATER





A finned-type unit with many advantages for heating viscous liquids to be withdrawn from storage tanks. At left: design for installation outside of tank. At right: design for installation partly inside of tank. Described in Bulletin 1642.



TWIN G-FIN SECTION

An all-purpose heater, cooler, condenser or heat exchanger having the widest heat transfer applications of any design on the market. More than 30,000 installed sections. At left: stack of TWIN G-FIN SECTIONS connected in series for desired temperature range. At right: cut-away view of section showing simple design and G-FIN elements. Described in Bulletin 1614.

GRISCOM-RUSSELL: PIONEERS IN HEAT TRANSFER APPARATUS

Stock Units

as well as special designs in HEAT TRANSFER APPARATUS

Besides its many special designs in heat transfer apparatus, Griscom-Russell also has *standard* designs that enable you to save time required for special engineering development and manufacturing processes.

Some of these standard units are shown and briefly explained on the opposite page. They include apparatus for practically every standard heating, cooling, condensing and heat exchange service, and for many special services . . . units with bare tube and finned tube heat transfer surfaces . . . units for cooling or condensing with water or air . . . units for heating with steam or hot liquids. Each type has thoroughly proven its effectiveness, excellent design, and sturdy construction in thousands of installations, and is based on the Griscom-Russell 80 years of experience in specializing on heat transfer apparatus.

Write for bulletins describing in detail the units that may meet your requirements for heating, cooling, condensing or heat exchange processes. Your request for further information involves no obligation.

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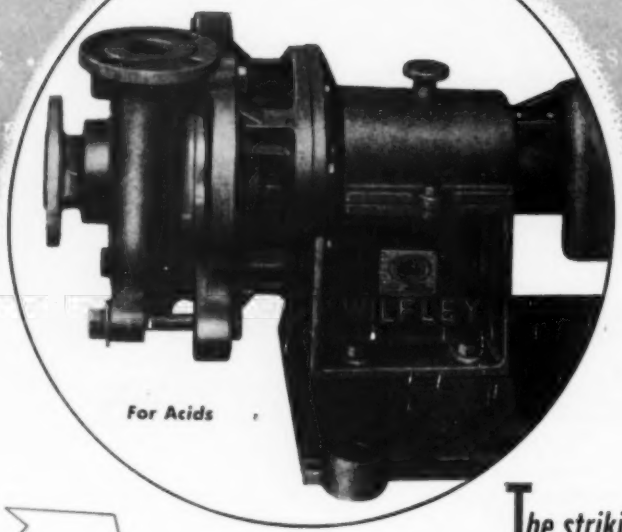
GRISCOM-RUSSELL

A BIG FACTOR IN COST REDUCTION



A Companion to the Famous WILFLEY Sand Pump

•

Buy WILFLEY for Cost Saving Performance

The striking efficiency of the WILFLEY Acid Pump—measured in terms of power saving and continuous, trouble-free handling of acids, corrosives, hot liquids and mild abrasives—is a big cost-reducing factor in most of the modern chemical plants of America. This is the acid pump that delivers full production on a 24-hour basis without attention. 10- to 2,000-G.P.M. capacities; 15- to 150-ft. heads and higher. Individual engineering on every application. Write or wire for information that will help reduce YOUR costs.

A. R. WILFLEY & SONS, INC., DENVER, COLORADO, U. S. A.
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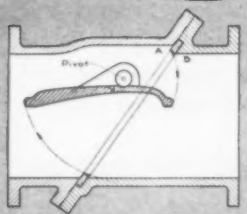
WILFLEY *Acid* PUMPS

Prevent Water Hammer

with the "CUSHIONED CLOSING" of

CHAPMAN

TILTING DISC CHECK VALVES



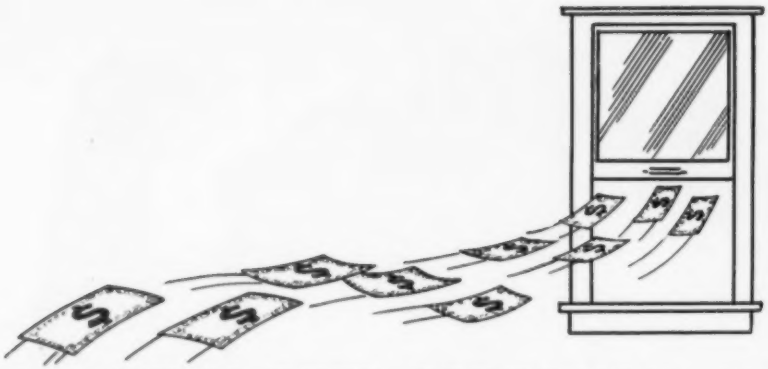
Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

Chapman Tilting Disc Check Valves *work with . . . not against . . . the stream.* As a result, destructive pipe line stresses are practically eliminated. Head losses, as compared with conventional type check valves, are reduced 65% to 80%.

This balanced disc rides smoothly on the flow. It lifts away easily when opening . . . closes quickly and quietly. There is no rubbing on the seat . . . no slamming. Hinge pins, seats and bearings wear far longer.

These are facts. Write today for engineering data and reports of tests. Valves available in either iron or steel.

The Chapman Valve Manufacturing Company
INDIAN ORCHARD, MASSACHUSETTS



HOW MUCH DOES CORROSION COST YOU?

You know what your labor and material costs you in the operation of your condensers and heat exchangers. But what about corrosion?

Is corrosion eating into your profits?

Are these some of the causes?

IMPINGEMENT ATTACK—this is due to turbulent flow or high velocity of the cooling water, generally occurring at inlet end.

SEASON CRACKING—this is due to internal tensile stresses in the metal plus a corrosive. Tubes shipped from the various mills are not subject to this type of failure due to the fact that all residual stresses are removed. However, it is possible that through, for example, improper storage, tensile stresses will be developed in the metal. Then, if in contact with a corrosive, this type failure could occur.

THINNING OF TUBE WALL—this is due usually to formation of soluble salts on tube surface. The constant sweeping away of corrosion products leaves freshly exposed metal in contact with the corrodent.

STRESS CORROSION—this is confined largely to brasses lower in copper content than 85%, is due to an externally applied tensile stress plus a corrosive.

These aforementioned types of corrosion are most common. There are many others.

You can combat corrosion. You can combat it by making sure that the tubes you select are of an alloy composition whose behavior is known under given conditions.

With our extensive experience (over 30 years) in manufacturing tube exclusively—and supplying the product for endless number of uses—we can be of great help to you in selecting tube of the proper alloy to meet your particular requirements.

Would you like our brochure about Condenser Tubes? We'll gladly send you a copy without obligation.

WOLVERINE TUBE DIVISION
CALUMET AND HECLA CONSOLIDATED COPPER COMPANY
INCORPORATED
MANUFACTURERS OF SEAMLESS NON-FERROUS TUBING

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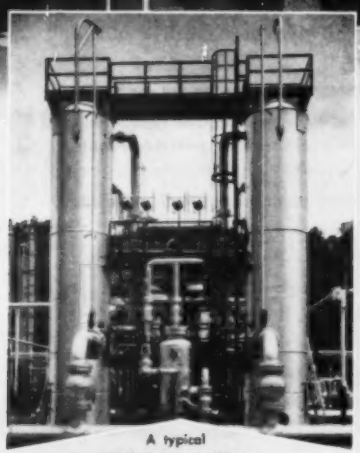
DEHYDRATION PLANTS...

. . . Another of Pritchard's
GAS ENGINEERING* Services That Can
SAVE YOU MONEY!

Glycol dehydration plant processing 33 million scf of gas per day with direct-fired reboilers and gas exchanger cooling.



A typical solid absorbent plant.

Dehydration plants, using either liquid or solid absorbents, are familiar projects to the engineers in the Natural Gas Division of J. F. Pritchard & Co. Many companies are turning to Pritchard's competent engineering staff for prompt, economical and effective solution to their most pressing gas treating problems.

Write TODAY for complete information on how Pritchard's Gas Engineering services in design, engineering and construction can be put to work profitably for you.

*** THESE PRITCHARD GAS ENGINEERING SERVICES ARE AVAILABLE TO YOU**

- Compressor stations and additions
- Pressure maintenance units
- Desulphurization, amine type
- Conditioning and treating
- L.P.G. installations
- Cooling and heat transfer
- Removal of liquids and dust
- Gasoline plants

J.F. Pco. — THREE FUNCTIONS — Engineering, Construction, Manufacturing — IN FIVE FIELDS — Serving the CHEMICAL, POWER, PETROLEUM and GAS industries as well as providing specialized EQUIPMENT for all industries.

NATIONAL CONSTRUCTORS ASSOCIATION MEMBER

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NATURAL GAS DIVISION

J.F. Pritchard & Co.

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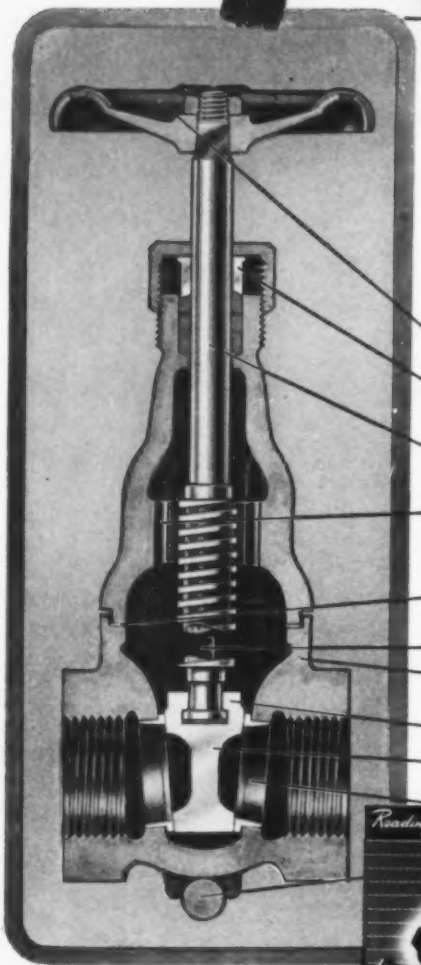
900 GRAND AVE. • KANSAS CITY 6, MO.

HOUSTON • NEW YORK • TULSA
ST. LOUIS • LOS ANGELES • PITTSBURGH • CHICAGO

many 4 features in this R-P&C valve



CLIP GATES were originally developed for temporary or light services in which a small iron valve was necessary or acceptable. But the design, material and workmanship of the READING-PRATT & CADY clip has made it a popular all-around small iron gate valve—suitable for almost any application within its size, pressure and temperature range.

Read the highlight features listed below. And for more detailed information, get in touch with the R-P&C District Office or Distributor nearest you.

1. **Kool-grip malleable iron ventilated hand-wheel.**
2. **Deep stuffing box with follower. Can be packed under pressure.**
3. **Stem of high strength steel or bronze rod stock.**
4. **Bronze bushing in brass-mounted type. Full, adequate bonnet drain prevents possible trouble from freezing in outside installations.**
5. **Male and female bonnet joint with asbestos gasket.**
6. **Full-sized wedge guides cast in body.**
7. **Body and bonnet of close-grained Electric Cast Iron—50% stronger than ordinary iron.**
8. **Horseshoe type slip-on connection.**
9. **Heavy cast I-beam wedge—reversible and renewable. Wedge rises above flow when open.**
10. **Rolled-in seat ring (in bronze-mounted type).**
11. **Full U-bolt in closed bolt holes. Held in place by 3 sets of lugs on body.**

SEND ***for this descriptive folder***

about R-P&C Clip Gate Valves. Just ask for **DH-952.**

ACCO

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R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

READING-PRATT & CADY VALVES

Controlled Quality

safeguards performance

OF EVERY LADISH SEAMLESS WELDING FITTING

Spectrographic analysis is but one of many Controlled Quality tests conducted by the Ladish Metallurgical Laboratory.

Unsurpassed metallurgical standards . . . are important safeguards by which Controlled Quality assures Ladish fittings of maximum physical properties necessary for peak performance . . . extra protection that you value more with each added year of reliable service.

TO MARK PROGRESS

A COMPLETE LINE PRODUCED UNDER ONE ROOF
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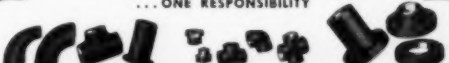

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For Improved Gasoline Quality use Du Pont Gasoline Additives

. . . a complete line to meet every need

Du Pont's complete line of gasoline additives makes it possible for you to meet your various needs—and obtain your entire requirements from one dependable source. These additives have been proved by many years use in the field. They are compatible with each other and are of uniform high quality.

Du Pont District Laboratories, one of which serves your territory, will gladly assist you in evaluating your fuel and in making the proper recommendations. Write the nearest District Office for additional information on this complete line of gasoline additives.

Chemical section of a District Laboratory. Also equipped to make octane determinations, they render many helpful services.

Tetraethyl Lead Compounds

. . . Motor Mix . . . Aviation Mix

Du Pont Tetraethyl Lead Compounds are backed by 25 years manufacturing experience. Friendly, cooperative assistance in the solution of problems involving the use of TEL are a part of the comprehensive services Du Pont offers in connection with its TEL compounds.

Gasoline Antioxidants

Nos. 5, 6, 22

All gasolines do not have the same likes and dislikes when it comes to antioxidants. That is why Du Pont offers you three gasoline antioxidants, from which you can choose the one best suited to your gasoline.

Metal Deactivator

Copper, an unwelcome catalyst in fuels, is easily and economically controlled with Du Pont Metal Deactivator. In every case, overcoming the catalytic effect of the copper is more economical with Du Pont Metal Deactivator than an attempt at stabilization with antioxidants alone.

Gasoline Dyes

Red, Blue, Yellow, Orange

Du Pont Gasoline Dyes establish the identity of your fuels. Four colors are available and the uniformity of these colors is maintained by careful control. Through mixture of two or more, a wide range of shades can be obtained.

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WATER COOLING TOWER
C.H. Wheeler
FAR OUTLASTS ITS DEPRECIATION PERIOD
Any water cooling tower "should" do all right for a few years, but after 5 or 10 years' service, users really appreciate the heavier, high quality materials and "tailor-made" construction of C. H. Wheeler. They still look and work "good-as-new" and continue to remain so for years and years, even where the installation location presents great weather extremes in summer and winter. Further, they are guaranteed to withstand hurricane winds up to 100 miles per hour. A good typical example of "5 year appreciation," and a repeat order, is shown in the photograph below, the latest installation, of course, being the new C. H. Wheeler "Funnel Top" Tower, which streamlines the flow of air from the water cooling zone to the Induced Draft Fans at the top of the tower. In 1955 or '60, you'll be glad, if you specify C. H. Wheeler Cooling Towers today. Write for Catalog No. 145.
C. H. WHEELER MANUFACTURING CO.
1818 Sedgley Avenue, Philadelphia 32, Pennsylvania
REPRESENTATIVES IN MOST PRINCIPAL CITIES
INSTALLED 1948
INSTALLED 1943
C.H. Wheeler
STEAM CONDENSERS • WATER COOLING TOWERS
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OF PHILADELPHIA

FOR YOUR HEAT EXCHANGERS OR CONDENSERS, THIS W&T CHLORINATOR CAN:

- Reduce down time
- Cut operating costs
- Improve heat transfer

The machine shown is a W&T Visible Vacuum Chlorinator for the application of chlorine to cooling water circuits through the W&T De-sliming process. Its design is the result of over thirty-five years of pioneering in chlorination, plus the accumulated experience of thousands of installations throughout the world.

Because of the care put into its design and construction, this chlorinator can do these things economically and dependably:

REDUCE DOWN TIME and eliminate costly plug cleaning by ridding condenser tubes of bacterial-induced slime growths.

CUT OPERATING COSTS by keeping condensers and other heat exchange equipment in service longer without shut-down and, at the same time, give higher operating efficiencies.

IMPROVE HEAT TRANSFER by keeping water-side surfaces continuously protected against the formation of a slime layer.

For complete information on how these advantages can go to work for you, write today. There's no obligation.

WALLACE & TIERNAN
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CHLORINE AND CHEMICAL CONTROL EQUIPMENT
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TODAY more petroleum refiners are using Filtrol Catalysts than ever before...

thermofor catalytic cracking
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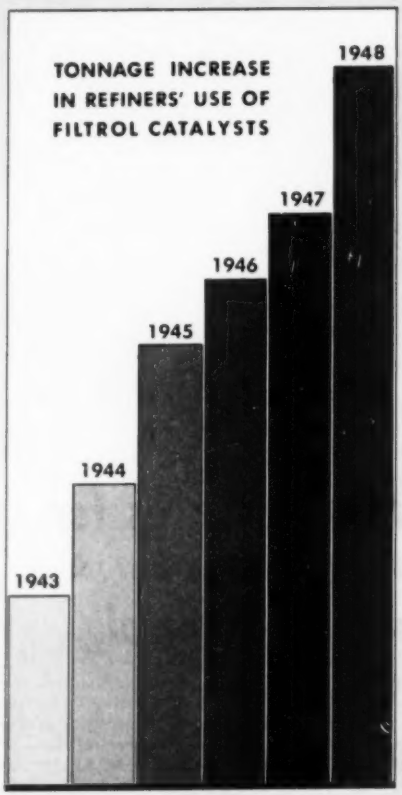

Their experienced judgment speaks for **FILTROL***

REFINERY EXECUTIVES, production managers and technical staffs responsible for economical refinery balance — the men that actually refine the bulk of America's production — use and specify more Filtrol today than at wartime peak.

• Experienced refiners compare catalysts at their practical optimum plant operation levels — integrated with overall refinery balance — and they continue year after year to specify Filtrol Catalysts.

More refiners use Filtrol Catalysts each year because — Filtrol Catalysts have proven to be more flexible, to produce quality yields from a wide selection of charging stocks with minimum cost of operation.

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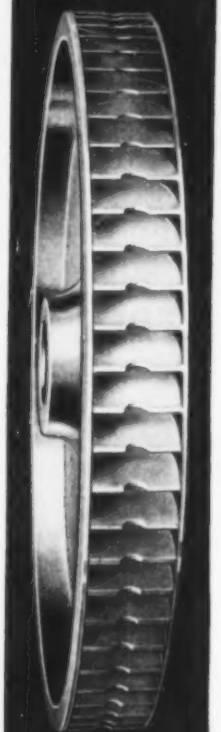
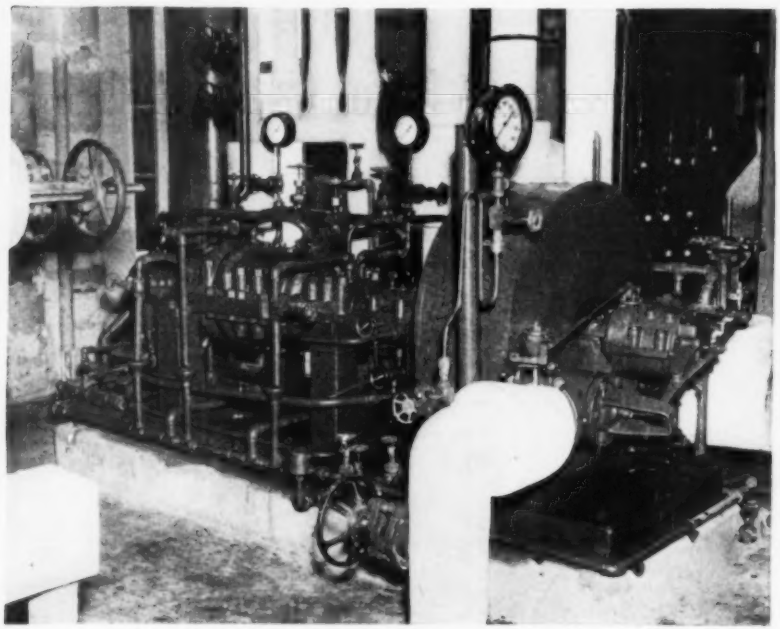
TERRY





Large Turbine Clearances for DEPENDABILITY *In Desuperheat Control*

In the design of this topping plant emphasis was placed on dependability and continuity of service.

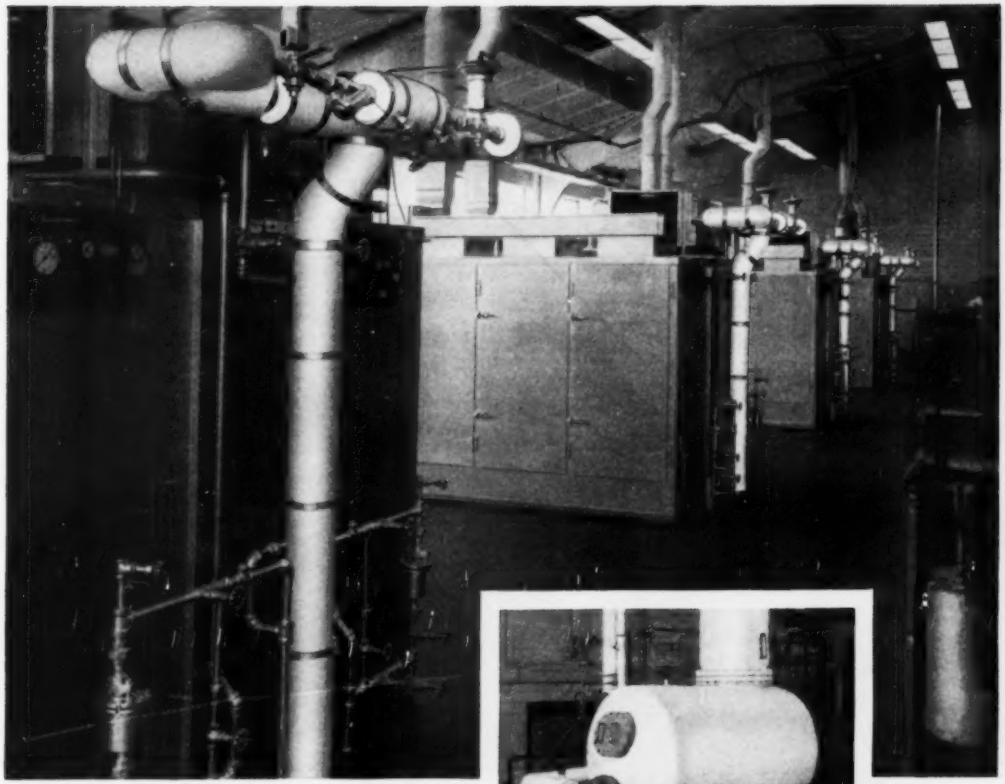
An important feature is pressure reducing and desuperheating 1250 psi, 900 F steam to 400 psi, 600 F, at various rates to meet low-pressure steam and power demands.

For this service the 100 hp Terry Solid-Wheel Turbine, shown above driving a desuperheating water pump, is ideal. It has large radial and axial clearances and protective rims at the sides of the wheel. The blades cannot foul, end play can do no damage.

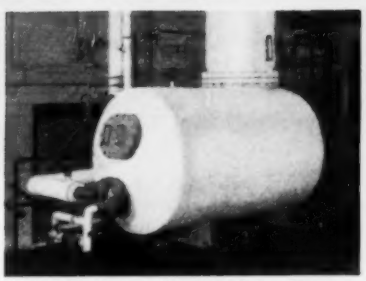
A descriptive bulletin on this dependable turbine will be sent upon request.

T-1180

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



Drying closets in plant of The Bayer Company Division of Sterling Drug, Inc., Trenton, N. J. The 60-lb. steam pipes are covered with K&M "Featherweight" 85% Magnesia Insulation, 2 inches thick, canvas pasted and banded.



Reclaim Solvent Still in the Trenton plant. Tank and tower are insulated with 2-inch 85% Magnesia Block, finished with asbestos cement; steam line with 2-inch thick 85% Magnesia; return line with Standard Thick 85% Magnesia.

Where temperature control is important—

Nature made Asbestos...
Keasbey & Mattison has made it serve mankind since 1873

K&M best in asbestos

K&M "Featherweight" 85% Magnesia Pipe Insulation

In the Trenton, N. J. plant of The Bayer Company Division of Sterling Drug, Inc. temperature control is vastly important. Insulation of *known* dependability is essential.

K&M "Featherweight" 85% Magnesia Pipe Insulation was used because in a wide variety of applications it has proved efficient and durable. It combines the high insulating properties of basic Carbonate of Magnesia with the proper amount of clean Asbestos Fibre as a binding element. It is extremely light in weight, easy to apply, fire-proof, mechanically strong. And is supplied in a wide range of sizes and weights.

K&M Distributors, located strategically throughout the country, are experts on the application of K&M insulating materials. Let them help you make important savings in your plant. Write us for further information.

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NEW ROCKWOOD BALL TYPE VALVES

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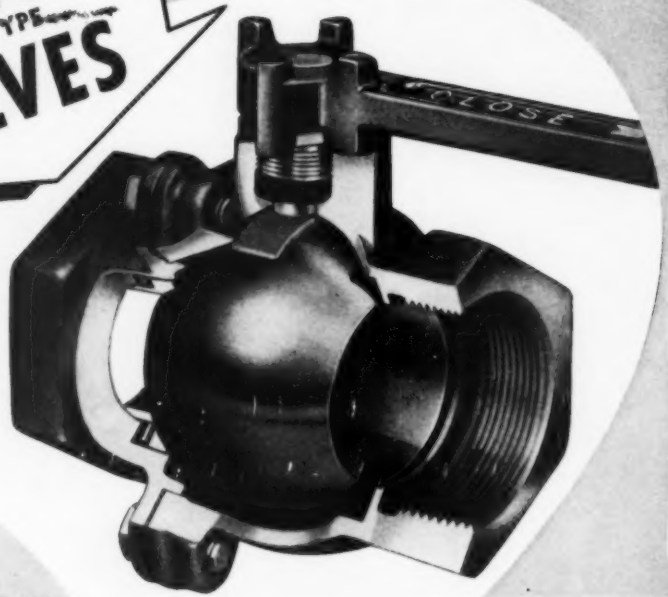

Recommended for 300 p.s.i. working pressure

Rockwood offers you a completely new type of ball valve with these outstanding features — full round flow, leak proof service and quick opening and closing. This new Rockwood Ball Type Valve will cut your production cost, reduce maintenance cost and increase the output of materials handled.

Chrome plated floating ball shut-off resists pitting, scratching and abrasion and in combination with the synthetic rubber seat, assures pressure tight seal and longer valve life.

Available in bronze in all pipe sizes from ½" to 2", the Rockwood Ball Type Valve is recommended for service in oil refineries, food, paper, propane, chemical and rubber plants, etc.

Further information may be had upon request. Write for folder V-4.

Distributors in all principal cities.

7 OUTSTANDING FEATURES

- **Full round open area — no turbulence in fluid stream**
- **Leak proof after continued use**
- **New floating ball — resists pitting, scratching and abrasion**
- **No exposed seating surface in open or closed position**
- **Easy to open or close under full pressure**
- **Installed in any position**
- **Quarter turn (90°) opening and closing valve**

ROCKWOOD

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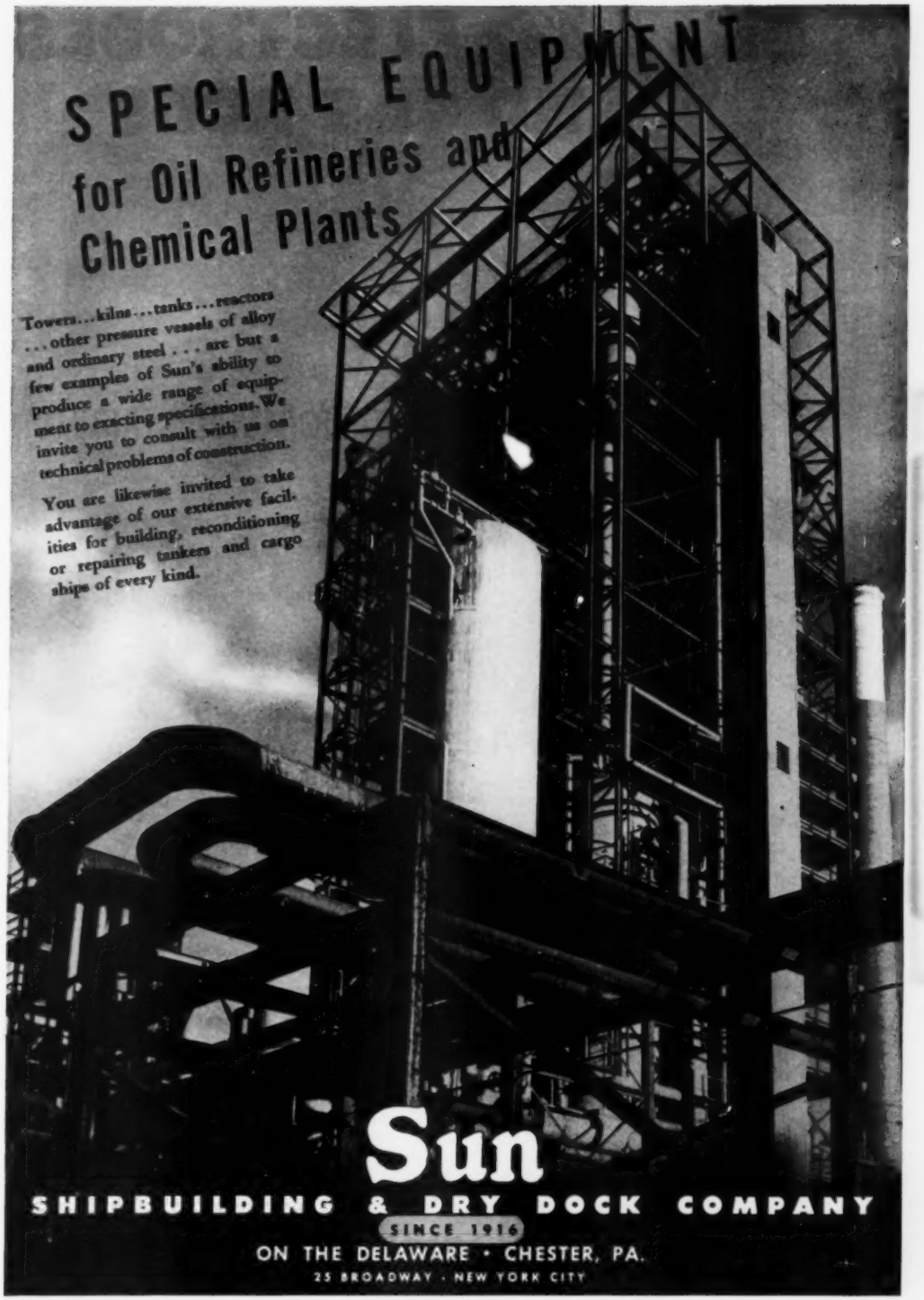
102 HARLOW STREET WORCESTER 5, MASS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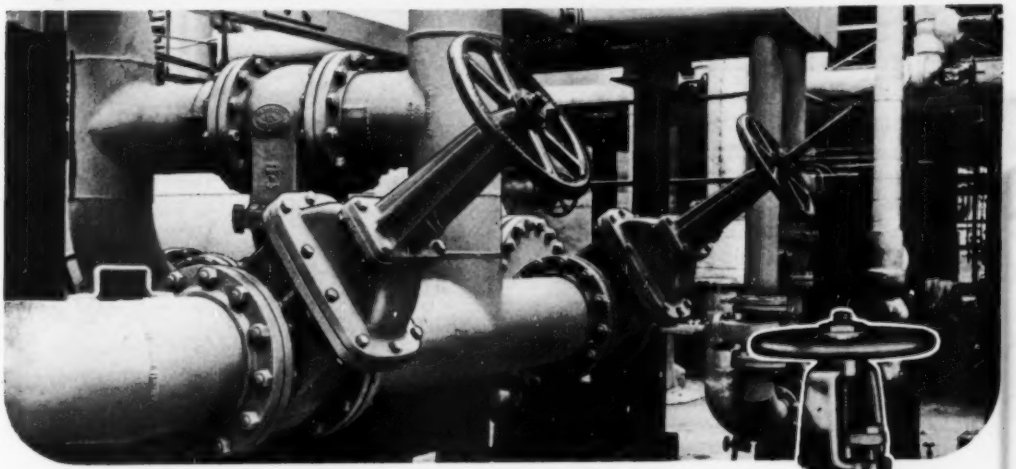

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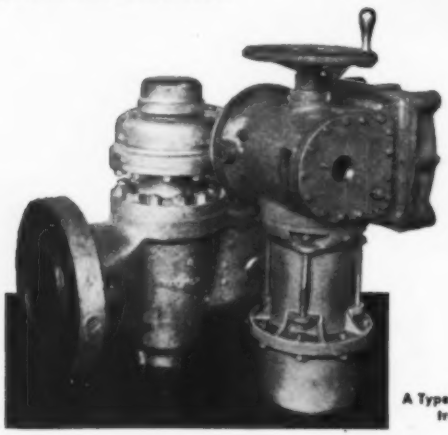

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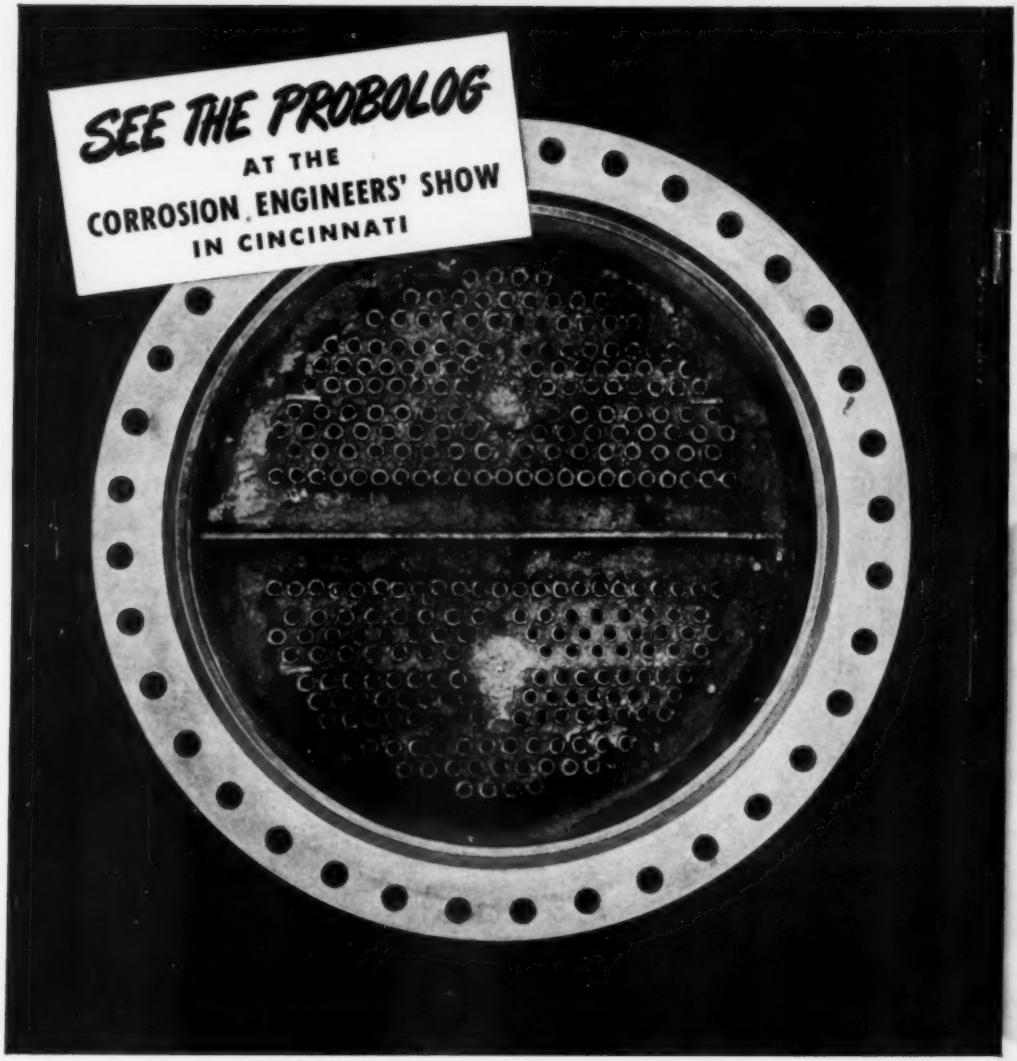

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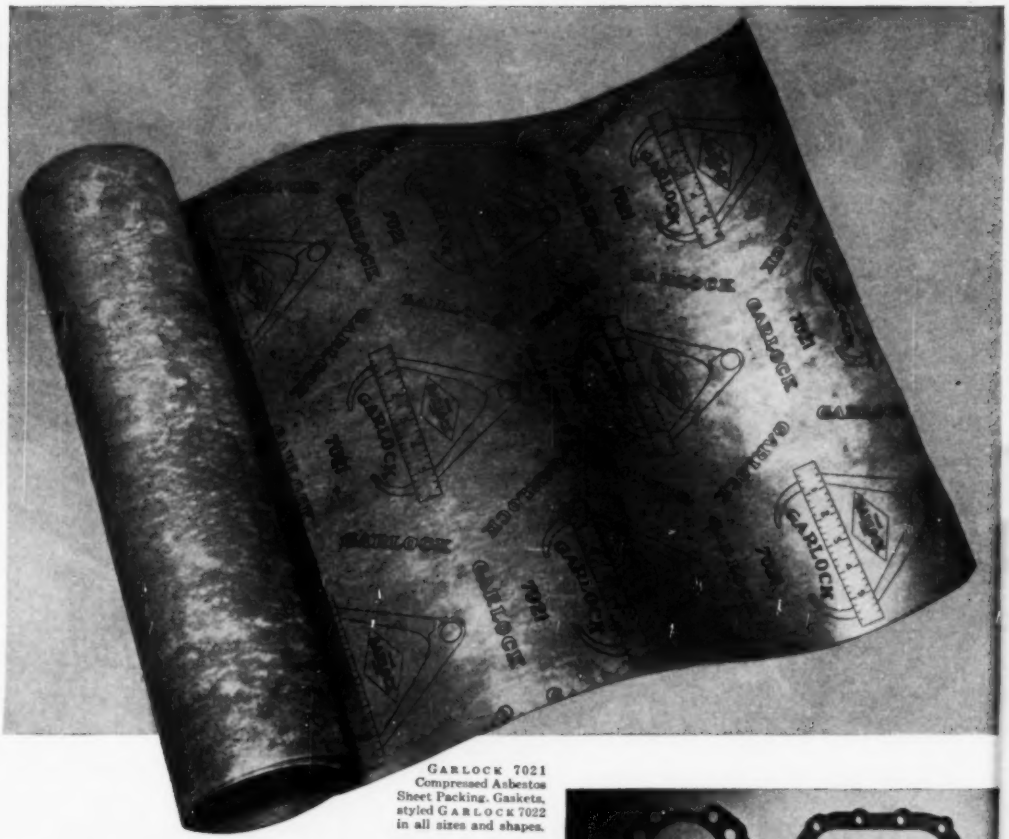

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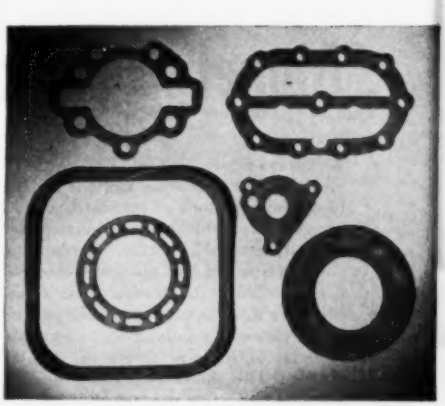

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Monel prevents corrosive attack by materials coming in contact with that surface. The steel base holds the tubes securely and insures the ability to reroll frequently, as tubes have to be replaced. Fabricators of condensers, economizers and other types of heat exchangers for the petroleum, food and chemical industries can now get prompt shipment of these corrosion-resistant plates.

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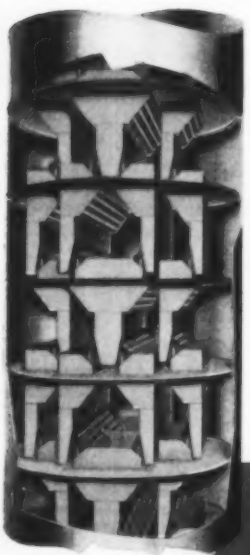
IF YOU ARE NOT ENTIRELY SATISFIED WITH THE RESULTS OF KOCH KASKADE TRAYS, RETURN THEM AND THE PURCHASE PRICE WILL BE REFUNDED TO YOU IMMEDIATELY.



Koch Kaskade trays are readily installed in existing towers. Delivery can be made in eight weeks — sooner if required. *Write or wire us, today.*

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AIRCO ANNOUNCES

The Aircomatic Process... An entirely new idea for welding aluminum in ALL POSITIONS

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Single or multi-layer welds can be deposited using either beading or weaving techniques. Vertical welds may be made with either upward or downward travel. In short, all of the facility associated with metal arc welding of steel is made available by this process, plus the advantages of high deposition rates, far exceeding those attained by usual welding methods, which results from continuous filler metal feed and the absence of slag.

This new welding method consists of feeding a bare filler metal in wire form at speeds ranging from 100 to 300 inches per minute through a manually operated gun. The filler metal carries welding current and an arc is maintained between the end of the wire and the work. Power may be supplied from a standard d.c. welding generator. The arc is maintained within a controlled envelope of shielding gas.

THE ADVANTAGES OF THIS TOTALLY UNIQUE AIRCOMATIC WELDING PROCESS INCLUDE:

- ...A manual welding process with the essential features of automatic welding.
- ...Continuous deposition of filler metal at high rates.
- ...Manual manipulation of an automatic process for welding in a vertical and overhead position.
- ...High quality weld metal deposits.
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- ...No flux required; slag removal eliminated.
- ...Visible arc; no blind welding.

Investigate the many advantages the new Aircomatic Welding Process *offers you. For equipment, price, service or other pertinent information, call or write our nearest office.*

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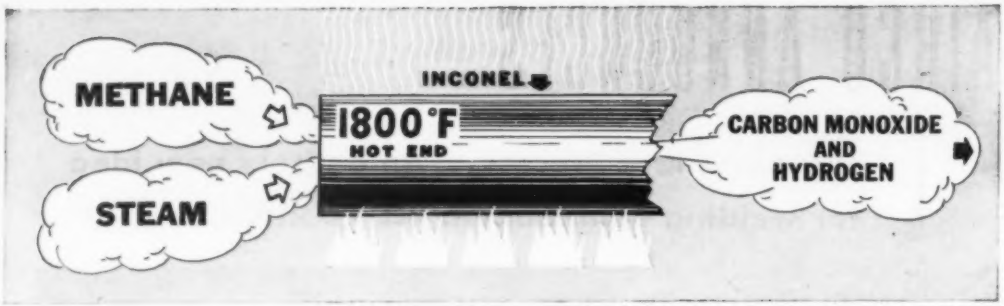
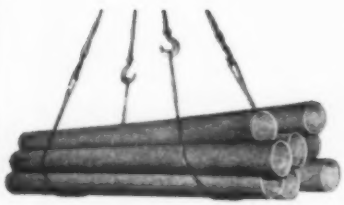


Hydrocarbon Synthesis—FROM METHANE AND STEAM

WILL INCONEL BE THE ANSWER TO THE HIGH TEMPERATURE PROBLEM?



LARGE DIAMETER EXTRUDED INCONEL TUBING IN VARIOUS SIZES!

You can order extruded Inconel tubing in outside diameters from 2½" to 9¼"; wall thicknesses from ½" to ⅝". Length varies according to diameter; ranges from 6' to 22'. For closer tolerances and thinner walls, sizes up to 4½" O.D. are produced by cold drawing. Write for complete information.

Inconel* is rightly regarded as one of the outstanding metals for resistance to high temperatures.

Now the questions are being asked: *Is Inconel the answer to the hot-end of hydrocarbon synthesis? Will Inconel have a service life measured in years rather than hours?*

Already On Trial

Nobody can say—but at least one manufacturer is using Inconel tubing for experiments in fuel synthesis from methane and steam. In this particular case, the components enter the synthesizer hot-end at a temperature close to 1800° F., passing through an Inconel tube that is heated on the outside by the combustion of methane. Inside surfaces of the tube operate continuously under carburizing conditions; the outside is exposed to severe oxidizing conditions.

Inconel was chosen because of its proved hot-strength and resistance to creep and carburization.

Other High Temperature Service

Inconel has been used successfully by heat treaters in both strongly oxidizing and reducing conditions...at temperatures up to 2000°F. Inconel fixtures serving over two years are still in excellent operating condition.

REMEMBER *Inconel when you're looking for materials to resist carburization and oxidation at high temperatures in hydrocarbon synthesis. Turn some of your problems over to our Technical Service. These men know what has been done (and what is being done) to provide durable metals for your kind of work.*

EMBLEM OF SERVICE INCO TRADE MARK

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Inconel*—FOR LONG LIFE AT HIGH TEMPERATURES

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DESIGNERS and MANUFACTURERS! Sand castings and precision castings of Monel*, Nickel, Inconel* and other Nickel alloys are available from Inco's own foundry, backed by a half century of experience with Nickel and Nickel Alloys.

PETROLEUM
REFINER

VOLUME 28, NO. 4 APRIL, 1949

The LOOK BOX

BILLS that have been introduced in Oklahoma and Texas legislatures, proposing processing taxes of one cent per gallon on gasoline, natural gasoline, and other fuels, represent serious threats to the industrial welfare of those states. If enacted, the measures would automatically increase by a cent a gallon the cost of delivering products from refinery docks into tank cars. Thereby, the processors involved would be seriously handicapped in interstate markets, because refiners operating in states imposing processing taxes would be placed at severe competitive disadvantage.

Case Against Processing Tax

One alternative would be to move plants into other states. Refining plants do not have to be located near producing areas. It is economically sound and feasible for them to be near marketing centers.

The refining industry is one of the largest manufacturing enterprises in each of these states, and its serious impairment would be a hard blow industrially. Employment would be reduced, and other lines of business would suffer.

Refiners that attempted to continue operating plants at their present sites would be forced, in order to compete, to pass the tax back to producers of their raw material. They would have to reduce the prices they could offer for crude oil or wet natural gas. The tax would mean about 19 cents per barrel of crude processed. For any producers depending on such refiners for a market, this decrease in revenue from crude oil would be the difference between operating at a profit or loss. Under such conditions, producers also might have to reduce their activities in these states and make greater effort to find production in states not imposing this tax.

In the case of natural gasoline, this proposed tax would be particularly bad because it would be an anti-conservation measure. Natural gasoline plants save the liquid components of natural gas produced along with oil from oil wells and make available properly dried gas for delivery into natural gas pipe lines for use by industry and homes. Without natural gasoline plants, the gas from oil wells, after lifting the oil to the surface, has to be flared or burned in the air and wasted to dispose of it safely.

Furthermore, the tax would be applied not once but twice in the case of natural gasoline. The one cent per gallon tax would have to be paid at the natural gasoline plant. But the natural gasoline goes primarily to oil refineries for use as a raw material in manufacture of motor fuel, and after this blending, it would be subject to the proposed one cent per gallon tax on motor fuel. Thus a total tax of two cents per gallon would be exacted on the natural gasoline.

Prior to the war the tank car price of natural gasoline at the plants was commonly only 2 to 3 cents a gallon, and except in 1947 and 1948 the price was under 5 cents even in the war and postwar periods, while in 1949 the price has been around 6 cents. For the past 10 years the average price has been about 4.6 cents a gallon. The proposed processing tax would be a large percentage of the normal or long term average price.

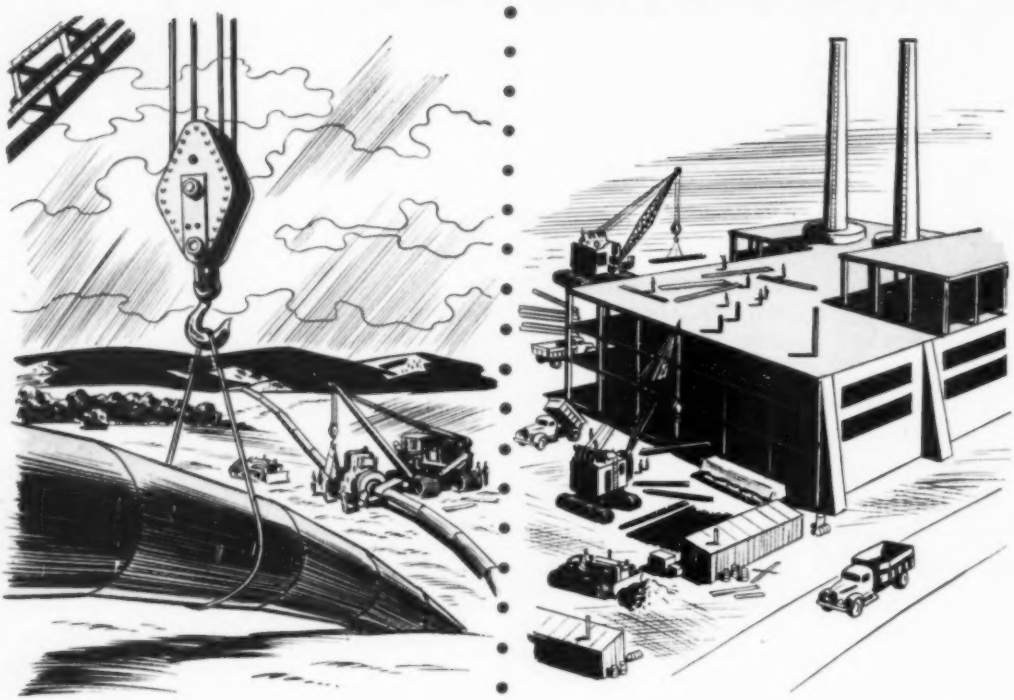
In the long run, through reductions in either refining or producing operations, or both, the states imposing these processing taxes would run the risk of losing more taxes than they would gain, besides suffering unemployment, reduced business activity generally, and other related ill effects.

THIS discussion likely would do the petroleum industry more good if it appeared in a "lay" publication, because the public, generally speaking, needs to be told over and over how the oil industry, within the space of a single year, changed the national supply picture from one predominantly brown, a serious shortage, to the bright, colorful one of ample supply.

Typical of Oil's Alert Operation

We in the oil industry know how it was done; how company after company put all other effort behind them until production, refining and trans-

FROM PIPE LINES TO PAPER PLANTS



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Whether your project calls for a pipe line or paper plant — refinery or chemical plant, Brown & Root is prepared to meet your exacting demands efficiently. Thirty-five years' experience in the industrial engineering and construction field assures clients the finest in planning, process analysis, architectural, and engineering skill.

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portation facilities had been built up to meet the ever-growing need of a nation's homes, farms, business and industry. There had been, perhaps, no less effort during the previous two winters, but at that time the activity was attended by such inefficient expediencies as extensive abnormal tank-car shipments of crude and products, and operation of uneconomical refining units.

The picture was changed by reason of these same companies having the courage to reinvest much of their current earnings into financing modern plants—plants to cope with the increasing demands for fuel oils and other products, which a year ago were in such short supply in various areas of the U. S.

These thoughts come to your observer as he looks at the annual reports which are coming to his desk right now. Standard Oil Company (Indiana) is typical of these companies which took positive and efficient steps to change the picture in such a brief period.

This company and its subsidiaries in 1948, just to mention one item, increased its refinery runs of crude oil by 16 percent, spending during that year $252 million on new facilities "to help lick the oil shortage." The record operations in 1948 were possible, company executives pointed out, "largely because of capital expenditures of $631 million during the past three years." This is 2.1 times the company's net earnings for the 3 years.

It was necessary, Indiana Standard officials declared, to use 68 percent of the net earnings of the last three years in addition to $244 million of borrowed funds, $143 million from changes for depreciation and depletion and $39 million from other sources to provide these facilities.

While now "over the hump," this company explains that major new investments are still required for, among other things, natural gasoline plants. Continued heavy drilling also is in order, this "to replace the oil reserves depleted during a record-breaking output in 1948, and to accomplish our aim of making a net gain in reserves each year."

So while the situation looked comparatively rosy as the books were closed for last year, alert companies know full well that the need for continuing the battle is ever present and that 1949 is not the time to relax.

The situation, of course, is made no easier by the oil industry's needs for more capital and the difficulty of raising new equity capital in view of high surtax rates, double taxation of dividends and threats of higher corporation taxes and of more government controls.

These are some of the things that those of us in the oil industry should keep in mind and not be hesitant to recite for the information of our "lay" friends as the opportunities arise. It's much better that they get the facts direct than it is for them to depend upon unreliable, and frequently prejudiced sources whose aims are inimical to a healthy oil industry.

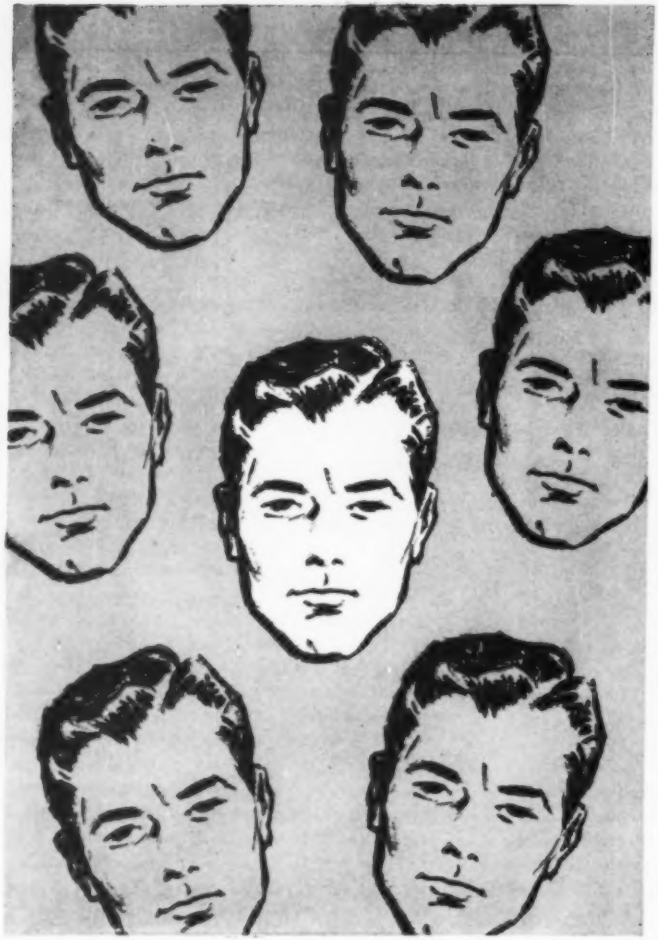
The Flow of Engineer Grads

THE enrollment in engineering colleges indicates a rapid readjustment back to prewar trends, according to an analysis made by S. C. Hollister, dean of engineering at Cornell University. Enrollment figures collected by the American Society for Engineering Education show a freshman enrollment this year of 48,000 in engineering, this against some 80,000 in 1946.

The present freshman class is slightly greater than the trend of freshman registration in prewar years. By 1952-53 it is anticipated that the number of engineering graduates will reach the normal trend extended from prewar years. Although the enrollments in upper classes are abnormally large due to a large veteran enrollment, Dean Hollister pointed out that these are, in considerable part, replacements for the large deficits during the war years, a deficit borne out by the acute postwar shortage of engineers. The problem of absorption of engineers in industry, if there be one, will develop next year or the year after. Beyond 1951-52, the number of engineering graduates each year will return to prewar trends or perhaps fall slightly below.

With stable economic conditions, Dean Hollister believes, the prospects for freshmen entering in 1949 should be good. A number of factors, such as the ones of far-reaching scientific and technical advances of the past few years, the use of engineering graduates outside the proximity of professional resources—all of these and many others may cause a sharp upward trend in engineering employment. It also is conceivable that a rapid development of a national emergency might actually find us with a short supply of engineers.

In recent months statements have been printed indicating that the rate of engineers being graduated is far beyond the demand and that unless some means of regulating the number of engineering graduates is invoked, the prospects for many young engineers of finding suitable employment in the profession will be poor. Reliable information on this subject, however, does not bear out statements being made.



One man may do the job today...

• Chances are that you can handle today's problem with your own operating staff. And chances are that you can meet tomorrow's problem. But chance is no basis of operation for the refiner who values his product quality, his processing equipment and his production schedule.

UOP

Economy Keynote of Bay Refinery Expansion Plan

By C. O. Garbrecht
Vice President,
Bay Petroleum Corporation

The combined capacities of our three refineries at Denver, McPherson, Kan., and Chalmette, La., originally totaled somewhat under 14,000 b/d. Today, after completion of several projects in our program of expansion, total capacity has been increased to 22,000 b/d.

C. O. Garbrecht

These projects involved not only the installation of new facilities, but the revamping of obsolete equipment and the conversion of wartime units. All work was designed and executed with an eye to maximum economy, existing equipment and materials being utilized so far as possible.

The design and engineering of these improvements was handled by Universal Oil Products Co., whose engineers have a particularly thorough understanding of our problems because of their close cooperation with Bay during a period of more than 12 years.

Original Refinery at Denver

The story of Bay Petroleum Corp. began with the planning of the Denver refinery. At that time, UOP was called upon to design a thermal cracking unit. The refinery started operating in 1937 and the completed plant was rated at 2,900 barrels per stream day.

The McPherson refinery, with a capacity of 3,000 barrels, was acquired in 1937, and the Chalmette refinery, with 8,000 barrels, in 1944.

Changes at Denver

Expansion and modernization at Denver involved the following: Enlarging the capacity of the thermal cracking unit. Installing a reforming unit of 1,000 barrels capacity, which could be used alternately for crude distillation. Installing a catalytic polymerization plant. Installing LPG equipment.

Universal engineers determined that in order to increase the capacity of the cracking unit a larger reaction chamber would be required. This released the old reaction chamber for service elsewhere.

The design of the reforming unit, permitting its use in crude distillation, gives the refinery unusual flexibility. It is currently rated at 5,000 b/d.

There was an idle gas recovery plant which had been built during the war to fit the refinery into the nation's 100-octane gasoline program. This unit produced a liquid butane-butylene fraction from the cracked gases, to be transported to another refinery as feed for a hydrogen fluoride alkylation plant. Daily production of 90-100 barrels of alkylation

(Advertisement)

feed stock made this the smallest Defense Plant Corporation unit in the entire aviation gasoline program.

This gas recovery unit consisted essentially of two fractionating towers, a depropanizer and a debutanizer. These were adapted to similar service in a non-selective poly unit, while the old reaction chamber from the cracking unit served as catalyst chamber of the unit which was to produce 100 b/d of polymer gasoline.

Facilities were also installed to recover liquid petroleum gas from the effluent of the poly unit. This equipment consisted of a small packed deethanizer tower from which the ethane passes overhead to the fuel line. The ethane tower also removes water which is drawn from the receiver.

The bottoms, comprising poly gasoline, butane and propane, flow to the depropanizer from which dry LPG is taken overhead. High vapor pressure polymer from the bottom of the poly depropanizer is charged to the poly debutanizer which produces a 10 lb. RVP polymer.

The Chalmette Refinery

The Chalmette refinery, operating on crude from nearby fields, is the largest of our refineries, having a capacity of 11,000 b/d. Work here included modernization of an obsolete combination skimming and cracking unit and installation of a catalytic polymerization unit.

The combination unit, which had been in the refinery when we purchased it, consisted of a vis-breaking heater, a cracking heater, a flash chamber and a fractionating column.

UOP inspectors found the flash chamber unfit for further service and it was replaced. A reaction chamber, a stabilizer and an absorption tower also were installed. As operated now, crude is pumped through heat exchangers where it picks up heat from the vapors coming from the flash chamber, thence into the fractionating column, where the straight run gasoline is flashed off. The topped crude then goes to the cracking heaters.

The catalytic polymerization unit was built from plans which had been prepared in the latter days of the war for a unit to produce a feed stock for alkylation to make a component of aviation gasoline. The plans were modified to build a unit to produce 175 barrels per stream day of motor polymer.

The McPherson Refinery

In the McPherson plant, a combination skimming and cracking unit, similar to that at Chalmette, was converted to UOP two-coil operation, and a thermal reforming unit, also usable for crude distillation, was installed.

A codimer unit in this plant had been operated during the war to produce C_4 codimer as feed for a hydrogenation unit in another plant. This unit was converted to non-selective poly operation, designed to produce 100 b/d of motor polymer gasoline. LPG facilities like those at Denver, were installed.

The McPherson plant currently runs about 6,000 barrels per day.

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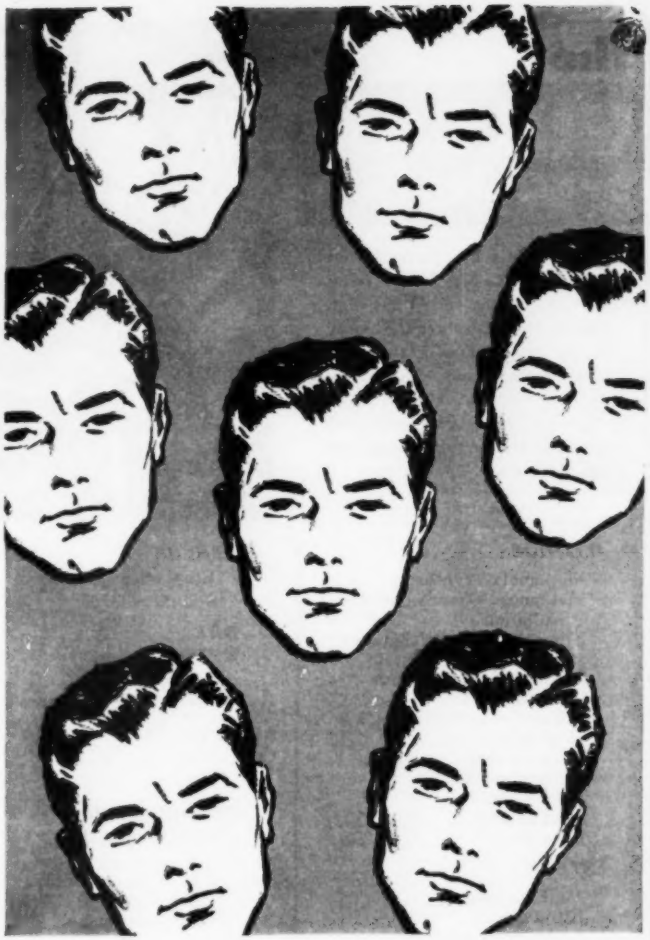

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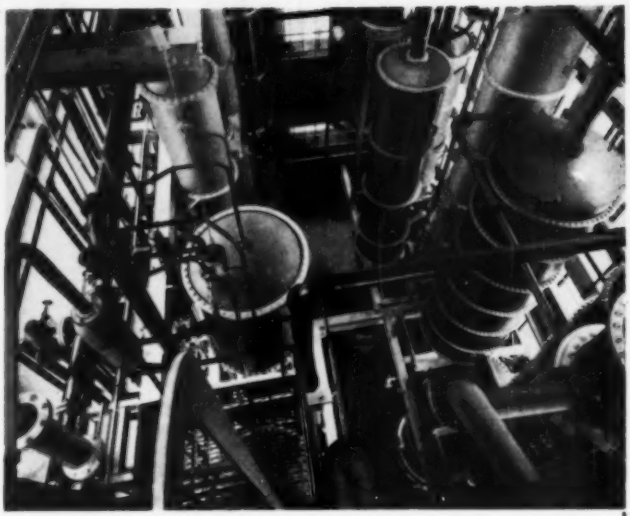
has served the Process Industries for forty-seven years, and throughout this period has been engaged exclusively in the highly specialized fields of Distillation, Evaporation and Extraction. Below is a representative list of chemicals now being processed in Vulcan-designed plants and equipment:



ALCOHOLS

Methanol — synthetic
Methanol — from wood distillation
Ethanol — industrial grades from molasses and grain
Ethanol — from sulphite waste liquor
Ethanol — anhydrous, Vulcan process
Ethyl alcohol — beverage, neutral spirits, beer
Isopropanol
Allyl alcohol
Butanol

ESTERS

Methyl acetate
Ethyl acetate
Isopropyl acetate
Butyl acetate
Vinyl acetate
Dibutyl phthalate
Methyl methacrylate

ALDEHYDES

Acetaldehyde
Butyraldehyde
Furfural

ETHERS

Ethyl ether
Isopropyl ether

DDT

KETONES

Acetone
Methyl ethyl ketone

GLYCOLS

Ethylene glycol
Butylene glycol

CHLORINATED HYDROCARBONS

Chloroethane
Chlorobenzenes
Chlorotoluenes
Trichlorethylene

HYDROCARBONS

Butadiene
Heptane
Benzene
Toluene
Styrene
Diphenyl
Hexane
Alkyl Benzenes

ACIDS

Formic acid
Acetic acid — from wood distillation
Acetic acid— from process residues and solvent recovery
Acetic anhydride
Propionic acid
Butyric acid
Stearic acid
Monochloracetic acid
Salicylic acid
Fatty acids

PHENOLS

Phenol
Naphthol

MISCELLANEOUS

Citronellal
Geraniol
Essential oils
Aniline
Monethylaniline
Diethylaniline
Oxygen
Hydrogen
Arsenic trichloride
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Nuclear Fission As a Source of Competitive Energy

T. R. HOGNESS
Director, Institute of Radiobiology & Biophysics
University of Chicago

The author delivering his paper at the recent Galveston meeting of the API Division of Production, Southwest Division.

THERE is as yet no such thing as atomic power, in the sense of the strict definition of power. But surely we shall have this power, and in the not too distant future. The principles are known, tentative designs for power reactors have been made, and many necessary preliminary experiments are under way. With our faith in the ability of our country's engineers to solve a very difficult problem, feasibility is fast growing into certainty.

Let us take it for granted that we shall have an atomic energy pilot power plant of at least some hundreds of horse power within five years, and one or more plants of 100,000 h.p., or more in 20 years. We produced heat from nuclear fission in three years, but to produce power is a far more difficult job. The period to be discussed is that beyond 1970.

My thesis is concerned with competitive fuels and must deal with costs more than 50 years hence—necessarily, a very general assay. To make this kind of cost projection, let us consider the present situation and then make some guesses about the future.

With the exception of atomic energy, all the energy produced on earth is the stored energy of the sun—water power (water stored against gravitational flow) is perhaps of the shortest storage duration, plant life next, and coal and petroleum products represent solar energy stored tens to hundreds of thousands of years. Atomic power is different. It competes with the sun. Unlike other fuels, atomic fuel exists in extremely concentrated form.

In 1946 the total energy consumed in the United States amounted to about 35,000 trillion Btu's. About 5000 trillion, accounted for by water power, can be discounted, for the purposes of our discussion, because water power is not a fuel and in the United States it will always be a minor factor in power supply. This then leaves us with about 30,000 trillion Btu.'s as the annual energy production from fuel. This same amount of energy can be produced from the fission of about 1¼ tons of Uranium 235 (U^{235}) a day—a cube of U^{235} about 15 inches on a side. (Such a compact mass of pure U^{235} could not exist as one unit without explosion).

What fraction of these 30,000 trillion Btu.'s could be considered in the competitive market with nuclear energy, and what is, or will be, the cost of producing this atomic fuel? To enable you to make any kind of guess about these two factors, you must first know something about the process of atomic fission and the principles of a power pile.

The Process of Fission

The two fissionable elements known to man are Uranium 235 and Plutonium 239 (Pu^{239}). The latter is a man-made element and with regard to fission behaves like U^{235}. For the purpose of our discussion our attention will be confined to U^{235}.

U^{235} and U^{238} exist together in all uranium deposits in the ratio of 0.7 percent U^{235} and 99.3 percent U^{238}. U^{238} is not fissionable and unless transformed cannot provide energy. For the purpose of bomb production, U^{235} must be used alone and must be separated from U^{238}. That separation process now takes place in our large plants at Oak Ridge, Tenn. For power production only, a concentration, and not a complete separation, of the U^{235} is necessary.

To understand the energy producing process of fission, neglect the presence of any extraneous material such as U^{238} and think only of the U^{235} atoms directly involved in the process of fission.

In a cluster—a certain mass—of U^{235} atoms each atom consists of a very small nucleus surrounded by a distant wall of electrons. Neglect this distant wall of electrons and confine attention to the very small nucleus. It is this nucleus that provides nuclear energy. Ordinary chemical energy is concerned with the changes in the wall of electrons. Energy from chemical reactions (concerned with the outer wall of electrons) is insignificant as compared with the energy derived from the nucleus. The fission of U^{235} provides 17 million times more energy, pound for pound, than does TNT. One pound of U^{235} provides as much energy as three million pounds of coal. A ratio of one part in three million can rightfully be called insignificant. Energetically, either petroleum or coal, pound for pound, is insignificant as compared with U^{235}.

Suppose a neutron passes through this mass of U^{235}—these neutrons are present in our surroundings, and many pass through our bodies each minute. If the mass is large enough there is a good chance that the neutron will hit the nucleus of some U^{235} atom and be absorbed. When it does, the U^{235} nucleus immediately becomes very unstable and—within one hundred-millionth of a second—splits into two parts of approximately equal masses with a tremendous evolution of energy. The two parts into which the nucleus splits, i.e., the two new elements formed, are very radioactive. But in this splitting process, this fission process, there are evolved more than two neutrons — those same neutrons that triggered off the splitting reaction. Let us assume that three neutrons are evolved in each fission process. These newly formed neutrons then can be absorbed by the nuclei of other adjacent U^{235} atoms and give rise to the splitting (fission) of these. The newly split U^{235} atoms in turn give rise to more neutrons and more splitting. The process accelerates itself and if there are enough U^{235} atoms in the vicinity we have a chain reaction and thereby a bomb.

The problem of the engineer is to control this reaction and to prevent its becoming explosive.

To control the reaction conditions must be so arranged that, for every neutron that is absorbed, only one of the neutrons ejected in the splitting process must be used to continue the reaction. The process can be illustrated graphically. In Figure 1 the U^{235} nucleus is shown to capture a neutron and then on splitting (splitting process is not depicted) emit three more neutrons. Only one of these emitted neutrons is

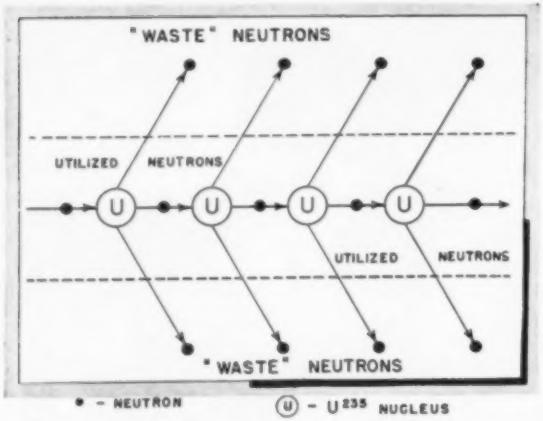


FIGURE 1

necessary to carry on the process. The others are "waste."

The "waste" neutrons can also cause U^{235} nuclei to split or explode but to control the reaction and prevent explosion they cannot be allowed to do so. They must be absorbed by the introduction into this mass, of other atoms which are good neutron absorbers. Cadmium is such an absorber, and the introduction of just the right amounts of cadmium can keep the reaction balanced and under control.

Other atoms than cadmium are good neutron absorbers. Boron is one of these. If the U^{235} as originally prepared is not sufficiently pure, i.e., if it contains too many good neutron absorbers (impurities) the chain reaction cannot proceed. Therefore the purification of the uranium becomes an important problem.

Utilization of "Waste" Neutrons

Practically all atoms absorb neutrons in their nuclei—some much more than others. The absorptive capacity depends upon the speed of the neutron. Usually, the slower the neutron, the more easily it is absorbed. For this reason materials which do not absorb neutrons but which can slow them down are placed in the vicinity of the U^{235} atoms. The neutrons are slowed down by the process of being bounced back and forth. Such substances are known as moderators—graphite is one of these.

When an atom absorbs a neutron it almost always becomes radioactive. Thus when Cobalt 59 absorbs a neutron it becomes Cobalt 60, a very radioactive element which is now replacing radium for therapeutic purposes. When nitrogen absorbs a neutron it splits into hydrogen and Carbon 14 nuclei. Carbon 14 is radioactive and from it can be made radioactive carbon compounds—radioactive gasoline, for example. In this way the waste neutrons can be used to make radioactive elements.

If an atom of U^{235} absorbs a neutron it becomes U^{236}. This latter element is radioactive and gives off two electrons in the course of its radioactive decay. In the course of this decay a new short-lived, man-made element appears, namely Neptunium 239 (Np^{239}). In several months' time it in turn forms the element Plutonium 239. This element, like Uranium 235, is fissionable.

$$U^{238} + n \rightarrow U^{239} \rightarrow Np^{239} + \text{electron}$$
$$Pu^{239} + \text{electron}$$

Suppose that we can arrange matters such that a large proportion of the waste neutrons are captured by U^{238} atoms. Some neutrons will always escape. Some U^{238} atoms are then transformed into Plutonium 239. We then make fuel as we consume it. How much fuel we manufacture will depend upon the skill of the designing engineer and physicist.

There is another species of atom that is fissionable, U^{233}, and it is made from Thorium. When Thorium 232 absorbs a neutron it becomes Thorium 233. It then undergoes radioactive decay and becomes U^{233}—this species, like U^{235}, is an atomic fuel.

Both U^{238} and thorium are then the cheap basic materials from which nuclear or "atomic" fuels can be made from "waste" neutrons.

Only one of the several neutrons emitted in each fission process must be utilized to produce more fission. But there must be utilization of at least *one* of these emitted neutrons. In fact, there must be the utilization of exactly one emitted neutron in a controlled reaction—no more, no less. How can we be sure of the utilization of at least one neutron? This is accomplished by the best geometrical arrangement of a) U^{235} atoms, for fission, b) moderator atoms such as carbon to slow down neutrons and make them more absorbable and thus decrease the number of U^{238} atoms necessary, and c) U^{238}, or Thorium 232, atoms to absorb the "waste" neutrons to make new fuel. Such a geometrical arrangement is known as a "pile" or a reactor. The term pile was first applied because of a want of a better name. It was just a geometrically arranged "pile" of material to accomplish this purpose.

Upon reflection, it should be obvious that a certain minimum amount of U^{235} atoms is necessary for a continued or a chain reaction—otherwise too great a proportion of the neutrons, newly produced by fission, escape through the walls of the pile and the reaction cannot proceed. Therefore a "critical" amount of U^{235} atoms is necessary before the pile or reactor can operate at all. This critical amount is the same whether the reactor operates at 5 watts or 1 million kilowatts. The length of time that the reactor can operate at these two extreme capacities will of course be different.

From this standpoint it will be clear that a reactor used for the purpose of driving an automobile or even a locomotive is impractical. It is as though we could not run our automobiles at all unless we first tanked up with a hundred years' fuel supply. Imagine your 150-h.p. automobile engine with a potential capacity of several hundred thousand horsepower. The excess capacity is waste and therefore the atomic power stations of the future will be large installations. That means more centralization of power supply.

Power Reactor

During the war the sole purpose of a reactor was that of producing Pu^{239} to make bombs—the heat was thrown away in the process of heating the waters of the Columbia River. The temperature of the pile was kept low to reduce the engineering difficulties.

To produce power, however, the temperature of the reactor must be high. The maximum efficiency of a power plant is determined by the Carnot equation: Maximum efficiency $= \frac{T_a - T_1}{T_a}$

where T_a is the temperature (absolute scale) of the influent material (steam or gas) and T_1 the effluent temperature. The greater T_a, the influent temperature, the greater the difference in temperature, the greater is the efficiency. But this temperature is governed by the ability of constructional material to withstand high temperatures.

To the mechanical engineer these are old problems already well in hand. But the pile designer must design for as high a temperature as possible, but he is restricted because he cannot insert into the pile materials which absorb neutrons unduly. This restriction rules out most of the common materials now used in boiler design. Any change in the kind of material used may radically alter the design of the pile.

There are no complete handbooks of pile design. The designer must be capable of making these handbook tables for himself.

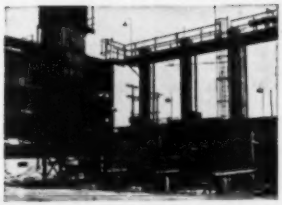
Radioactivity Problem

When U^{235} undergoes fission it emits neutrons and gamma rays. Furthermore, the products of fission are also radioactive. As a result, the radioactivity emitted by a large pile is thousands of times greater than all the purified radium in existence. To protect the workers about such a pile, a shield of quite a few feet of concrete is necessary. Concrete is the material chosen since it is cheapest and since lead or a heavier material offers no better shield for neutrons.

This is another reason that power piles of the future cannot be used for automobiles or locomotives. Imagine driving a car or a locomotive with an engine housed within 5-foot walls of concrete on all sides.

These considerations do not apply to a ship. In this case, sea water can offer a good shield, and large ships use enormous amounts of power.

The radioactivity of a reactor offers another problem to the designing engineer. The boiler tubes cannot be located in the hot fissioning mass of the reactor, because 1) the water with its dissolved salts will become radioactive or the water itself wil decompose into hydrogen and oxygen, and 2) material for the boiler tubes, which cannot absorb too many neutrons and which must be strong, is not a common commercial product. The problem then is that of getting the greatest amounts of heat out of a concentrated heat center in the shortest possible time without carrying the



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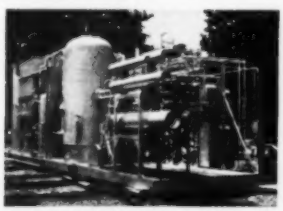

CARBON DIOXIDE: Portable CO_2 plants, built by Girdler, are an important factor in the world-wide production of America's greatest soft drink.

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Exploring Engine Cleanliness

Single-cylinder engine test method, developed by Ethyl Laboratories, offers refiners economical tool for studying complex problems of varnish and sludge deposits.

THE PROBLEM of keeping engines free from varnish and sludge deposits is not new—but it is one that is increasing both in importance and complexity as advances are made in engines, fuels and lubricants. Recognizing engine cleanliness as part of the over-all problem of engines, fuels and lubricants, the Ethyl Laboratories have worked extensively in helping to build up a background of information on the factors contributing to the formation of varnish and sludge.

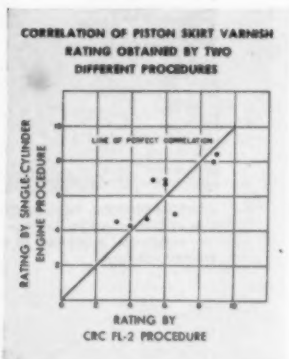
A complex problem

Some of the complicating factors involved in engine cleanliness are:

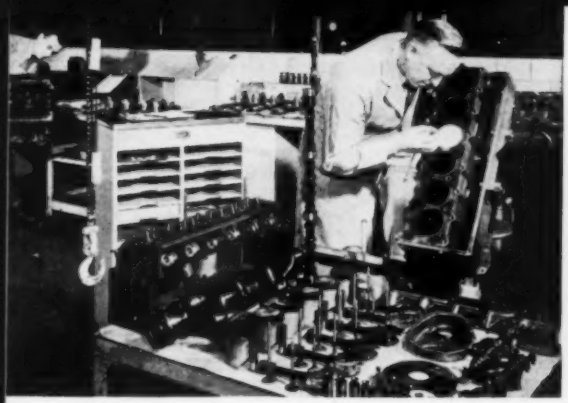
1. *The steadily widening range of engine operating conditions—with the extremes becoming increasingly severe.*
2. *The astronomical number of possible chemical reactions among fuels, antiknock compounds, lubricating oils and oil additives.*
3. *Engine design characteristics and the type of service in which the engine is employed—both of which have a decided effect on the amount of deposit.*

It has been known for some time that the type of lubricating oil may, under high temperature operating conditions, be the controlling factor in the deposition of sludge and varnish. More recently it has been demonstrated that gasolines vary in their tendency to assist in the formation of deposits. The greater complexity of the problem than was indicated at first accented the need for an economical test method that could be used for screening and preliminary tests.

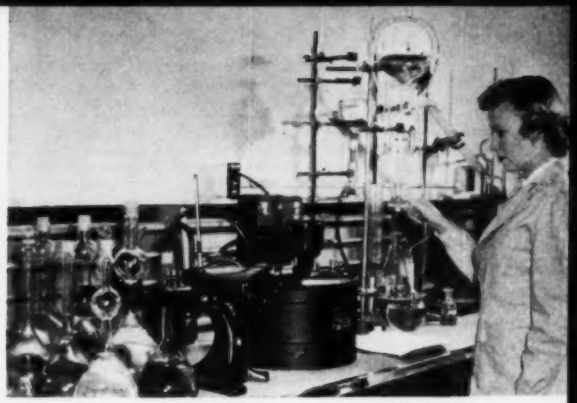
Ethyl's test method employing a single-cylinder engine provides an economical means of evaluating varnish-forming tendencies of fuels.


CORRELATION OF PISTON SKIRT VARNISH RATING OBTAINED BY TWO DIFFERENT PROCEDURES
LINE OF PERFECT CORRELATION
RATING BY SINGLE-CYLINDER ENGINE PROCEDURE
RATING BY CRC FL-2 PROCEDURE

Cleanliness ratings of fuels obtained by the single-cylinder engine test method correlate satisfactorily with those obtained by multi-cylinder engine test method.



After the CRC multicylinder engine test has been completed, detailed inspections are made and engine cleanliness ratings assigned to the various parts.



In the Ethyl Chemical Laboratory gasoline is analyzed to determine hydrocarbon type as a basis for study of engine cleanliness as related to composition of fuel.

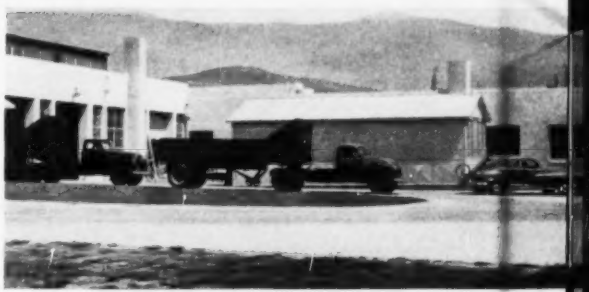
An economical test procedure

An important contribution of Ethyl's research has been the development of a test method that permits many of the studies formerly carried out on multicylinder engines to be made on a small single-cylinder engine without expensive dynamometer and associated equipment.

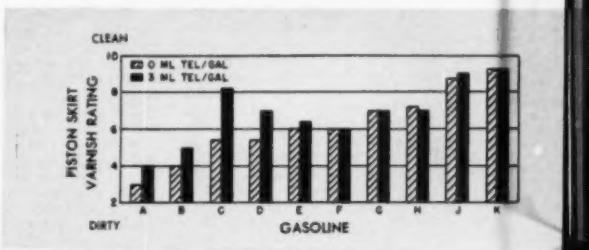
The smaller single-cylinder engine uses only 14 gallons of fuel per test run—compared to 180 gallons for the multicylinder engine; thus engine cleanliness ratings can be obtained on small samples of experimental fuels.

Research related to engine cleanliness is only one of the many services provided by the Ethyl Laboratories for oil companies. A comprehensive and continuous research program provides information that assists refiners directly in the economical production of satisfactory gasoline and furnishes basic data which serve as a foundation for development work related to gasolines, engines, and crankcase oils.

This message is the thirteenth in a series dealing with problems faced by refiners in producing gasoline for today's and tomorrow's engines, and the contribution of the Ethyl Corporation to their solution. Future messages will discuss other phases of this complex problem.



Wide ranges of weather and topography near Ethyl's San Bernardino Laboratory are ideal for vehicular research on engine cleanliness.



Research on ten different fuels showed that the addition of "Ethyl" antiknock compound tended to reduce varnish deposits on piston skirts.

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radioactivity into the turbine or engine, without too much neutron absorption, and without rupture of any point. Any rupture can lead to catastrophe. A safety factor of three to five is permissible in most engineering design. For the pile designer that factor must be close to infinity—a rupture or break would be catastrophic.

The contemplated design is therefore one which uses a circulating heat exchange substance—gas or liquid—which takes the heat out of the pile rapidly and conveys it to the steam boiler or to the gas heater of a gas turbine, making use of materials which are very special.

In spite of the extreme difficulties that beset the present-day designer, it appears certain that within the next five years we shall have made the first power pile—a small pile, to be sure.

Such a pile can be regarded as a prototype and one which will use atomic fuel on a premium base—a pile that might be used on a submarine and for which the cost of the fuel is a relatively unimportant factor. But from such a prototype will grow the competitive power piles of the future.

The Breeding Principle

The fission of each U^{235} atom produces more than two neutrons. One neutron must be used to continue the chain. Therefore more than one "waste" neutron will be left over. Suppose that our engineers and physicists were clever enough to so design a pile that the efficiency of utilization of these "waste" neutrons gave rise to more fuel than was consumed.

Assume that for each pound of nuclear fuel used (U^{235}, U^{233}, or Pu^{239}) 1.1 pounds of fuel is produced. Considering the cheapness of thorium and U^{238} as compared with U^{235}, this would be like sifting ashes and getting back 2200 pounds of coal for every 2000 pounds burned. Suppose that this turnover occurred every year, and further suppose that the efficiency in recovering the remade fuel was 100 percent. This last assumption could be included in the first; namely, that 1.1 pounds of fuel are made from 1 pound of fuel consumed, which is within the realm of possibility. Then the situation would be something like that depicted in Table I. In making this table it is assumed that in 1970 the consumption, in the beginning, shall be at the rate of 100 pounds every year, a very conservative estimate. But one must bear in mind that, because of critical size, many times this amount of U^{235} is necessary to start enough piles to consume this amount. The consumption-production table is then as follows:

TABLE 1

YEAR	Consumption	Production
1970	100.0 lb.	110.0 lb
1975	161.0	177.1
1980	260.5	286.5
1985	419.5	461.5
1990	675.6	743.2
1995	1,088.1	1,196.9
2000	1,752.6	1,927.9

In 30 years we produce about 20 times as much fuel as we begin with, and our power production goes up proportionately. Assuming again that we consumed only 100 pounds in 1970, by 2070—100 years later—we should be producing more cheap nuclear fuel than the country could use for all purposes. Such a calculation does not take into account the amount of material we can produce as starting material by our present processes. In less than 100 years our country can be placed on a cheap atomic fuel basis providing we are good enough engineers to utilize the breeder principle. Atomic fuel should yield 10 percent—a very good investment.

In considering the cost of nuclear fuel, let us not be restricted to U^{235} only. When once we get started in the peacetime pursuits of nuclear energy, Uranium 238 and thorium will do quite as well as U^{235}.

Competitive Costs of Fuel

The cost of coal today averages somewhere between $6 and $7 a ton for the large consumer. More than one-third of this amount is required to bring the coal to the surface. The remainder is accounted for by handling, distribution, selling, maintenance and amortization of equipment, and profits. The cost of mining coal has risen about 2½ fold in the last ten years and about fivefold in the last 50 years—this in spite of the tremendous increase in mechanization of mining. The other costs associated with coal costs, except profits, have risen proportionately. The cost of coal is very closely related to the cost of labor and there is every indication that the cost of coal will therefore continue to rise. History tells us that all regressions in this trend of earnings of the worker (or labor costs) have been only temporary. The cost of living and earnings have increased some tenfold in the last 100 years. So we may expect that the cost of coal will increase accordingly, particularly when we take into consideration that the coal industry is already highly mechanized and that the thicker and more available seams are now being mined.

It is only in the field in which petroleum now competes with coal that we could expect most of the competition with atomic power. We can expect an increase in the price of petroleum products, but this increase may come about largely because of lack of reserves, and hence when oil must be produced from coal it will be determined by the price of coal.

The cost of fissionable materials is a most difficult prediction to make.

At the present time, the United States government pays $3.50 a pound for U_3O_8 in ore that contains 10 percent or more U_3O_8—minus refining costs. The Canadian government pays $2.75 a pound of U_3O_8 in concentrations greater than 10 percent with no deductions for refining. Since concentration processes are secret, it would seem that the Canadian government's price basis is the better one. From this figure we can make some estimate of the cost of uranium metal. The duPont company is now producing titanium on a small scale and selling it for $5 a pound. The cost of mining and refining the ore is small as compared with that of uranium. The refining process is a difficult one. From these facts we can guess that the figure will be somewhere in the neighborhood of $10 a pound.

Assume that only the U^{235} (0.7 percent) in the uranium is utilizable for fuel, and that the U^{238} is discarded. Then the metal costs alone would be $1400 a pound for the U^{235}. But the cost of extracting the U^{235} from the uranium ($U^{235} + U^{238}$) is enormous. The government spent hundreds of millions of dollars to carry out this operation. The cost of producing one pound of U^{235} today is enormous, but nobody knows the cost of this operation under peace conditions.

But this is by no means the whole story. The U^{238} cannot be completely consumed before its "ashes are sifted" many times. It must be re-refined several times before it is entirely used up. So the costs mount up. Furthermore, an adequate supply of uranium might be very questionable. On this basis, U^{235} could hardly be considered as a competitive fuel.

Assume that the breeder principle is employed in the pile operation. Then, once started, all the uranium, including the U^{238}, becomes eventually utilized as fuel, and the initial cost of the metal to serve as fuel is then less than 1 cent per equivalent ton of coal. But to this must be added the costs of re-refining to get back the newly made fuel. This re-refining cost could be as low as or even lower than $10,000 a pound. But bear in mind that this pound is equivalent to 1500 tons of coal. A cost of $10,000 a pound would be equivalent to $7 a ton for coal. But this cost is only a guess. Factors about which little is known are maintenance and amortization costs. This is assuming a peaceful world, the cost of uranium not including the maintenance of the FBI, armed guards, etc.

The cost of the plant to accomplish this re-refining will always be very great, but after such a plant is built the labor costs are relatively small. It must always be borne in mind that production costs that do not involve a very high proportion of labor costs usually become cheaper than anticipated. When we first made synthetic rubber at one dollar a pound we thought we could do well if it were cut to 50 cents a pound. Today its price is about 20 cents a pound.

Added to these costs are the great costs of the power pile or the nuclear firebox itself.

At the present time and therefore for any future prediction, cost figures cannot be laid out in the same way that the engineer does today for his board of directors' consideration. I have therefore only tried to convey to you my conviction that in keeping with economic trends and with faith in our engineers the process of producing power from nuclear fission is an entirely feasible one and might easily compete with coal as a fuel.

Fuel Reserves

Practically nothing is known about the reserves of uranium. Before the new atomic age, uranium had no other use than in ceramics. It was a by-product of the radium and vanadium industry and was considered a waste product. Today uranium has replaced gold in the efforts of the prospector.

The three great concentrated deposits of uranium are in Canada, the Belgian Congo, and Czechoslovakia. The Czechoslovakian deposits, now under Russian control, are the oldest and the smallest. But these deposits were mined for radium and not uranium. For the small radium industry, the concentration of radium, and hence uranium, had to be high for economical exploitation. With uranium at its present price, many deposits formerly of no value at all became valuable.

The earth's crust contains .0004 percent uranium. The Atomic Energy Commission is willing to consider some ores containing as little as 0.1 percent uranium—only 250 times more than the average of the earth's crust. Certainly there must be a plentiful supply of this

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element, particularly when we consider that our total needs will amount to about a ton or two a day. We successfully refine copper from ores about as lean as this, and the market price of metallic copper is now about 20 cents a pound, and copper is only four times more abundant in the earth's crust than is uranium. There are hundreds of thousands of tons of thorium in proven deposits. Most of these deposits are located in India and Brazil. But we, too, have deposits of thorium. Up to the present time thorium has been mined, together with the rare earth elements, principally for the Welsebach mantel industry. Again there has not been much incentive for exploration. There is much more uranium and thorium in the earth's crust than there is coal and petroleum combined. As yet we have not found these elements in as many concentrated formations.

Of all the competitive fuels under consideration, petroleum shows the least promise with respect to reserves. The present proven reserves in this country correspond to a 10- to 15-year demand. It is true that more oil is now being discovered than is consumed, and no doubt this condition will exist for some years to come, but it must be obvious that the discovery of new fields cannot continue indefinitely.

The proven coal reserves are enough for about 2500 years at the present rate of consumption, and the proven reserves for all fuels, about 1700 years. When the coal is gone, then we will be forced to the use of atomic and solar energy.

Economic Implications

Assume that we have no atomic war and that at some future time atomic energy will successfully compete with coal to the extent that it practically replaced coal as fuel. What then might be the picture of our economic life?

The country would be studded with 100 or more electrical generating plants, each with a capacity of a million or more kilowatts. This would not imply that each reactor—each firebox—would have a capacity of one million kilowatts. Several reactors would be grouped together with one chemical plant for separating the radioactive materials from the unspent and newly-made nuclear fuel. Such chemical plants are very expensive. The most economical method of operation would undoubtedly involve large installations. Large metropolitan areas might be equipped with heating piles to produce steam for heat. More isolated homes would be heated by electricity. There would be no smoke problem.

Railroads operating by electricity could easily find it more economical to get their power from the power producers. This might mean that the railroads and the power producers would be closely affiliated with each other. Would it mean that both railroads and power plants would be owned by the government?

Could private enterprise finance such a stupendous project, costing some hundreds of billions of dollars?

Fuel for vehicle transportation would not be affected by atomic energy, for the shielding problem and the very much oversized power plant necessary would make the use of atomic power for this purpose impractical and prohibitive.

Atomic energy will therefore not put the petroleum industry out of existence. It is certain there will always be a thriving petroleum industry, but that industry 100 years hence, like other power industries, will undoubtedly be entirely different from what it is today.

Proved Petroleum Reserves Of U. S. Reach New Peak

PROVED reserves of crude, natural gas liquids, and natural gas in the U. S. reached new all-time peaks at the end of 1948. The year broke all previous records in the proving up of new reserves of liquid hydrocarbons and brought a relatively large proving of new natural gas reserves.

The nation's reserves of oils were expanded in 1948 in proportion to the year's relatively large increase in production, both reserves and production having been increased somewhat more than 8 percent. In terms of years supply at prevailing rates of production, reserves at the end of 1948 were the same as at the end of 1947—11.6 years for crude and 12.3 years for all liquid hydrocarbons.

These facts are revealed by the latest annual estimates of reserves by the API and the American Gas Association.

The reports estimated the total reserves of all liquid hydrocarbons in the United States at the end of 1948 at 26,821,227,000 barrels, including 23,280,444,000 barrels of crude oil and 3,540,783,000 barrels of natural gas liquids (condensate natural gasoline, and liquefied petroleum gases). The total was 2,079,567,000 barrels or 8.4 percent more than the total at the end of 1947. This annual increase was the first to exceed 2 billion barrels since that of 2,443,868,000 barrels in 1937.

Production of crude oil and natural gas liquids in the U. S. was estimated at 2,186,197,000 barrels during 1948, an increase of 174,970,000 barrels or 8.7 percent over the preceding year.

The industry proved up 4,265,764,000 barrels of new oil reserves in 1948, the greatest amount ever proved up in a single year and the only year in history in which 4 billion barrels or more have been blocked out. The 4,265,764,000 barrels of new reserves proved up in 1948 included 3,795,207,000 barrels of crude and 470,557,000 barrels of natural gas liquids.

Natural gas reserves also were increased substantially in 1948. U. S. reserves of natural gas were estimated at 173,869,340,000,000 cubic feet as of December 31, 1948, an increase of 7,942,426,000,000 cubic feet or 4.8 percent over the 165,926,914,000,000 cubic feet in reserve at 1947's close. This increase was not quite as large proportionately as the gain in production for the year. Production was estimated at 6,007,628,000,000 cubic feet, an increase of 377,817,000,000 cubic feet or 6.7 percent more than 1947's output of 5,629,811,000,000 cubic feet.

The nation's reserves of nearly 174 trillion cubic feet of gas at the end of 1948 were equivalent to 28.9 years production at the rate which occurred in 1948. The reserves of nearly 166 trillion cubic feet at the end of 1947 were equivalent to 28.4 years production at the 1947 rate.

Summary of Changes in 1948 in Proved U. S. Reserves of Crude Oil, Natural Gas Liquids, and Total Liquid Hydrocarbons
(All Oils)

Estimates on crude oil from American Petroleum Institute; and on natural gas liquids and total liquid hydrocarbons from American Gas Association and American Petroleum Institute, working together.

(Barrels of 42 U. S. Gallons)

CRUDE OIL		
Total proved reserves of crude oil as of December 31, 1947		21,487,685,000
Revisions of previous estimates	+1,958,853,000	
Extensions of old pools	1,439,873,000	
New Reserves (new pools) discovered in 1948	396,481,000	
Proved reserves added in 1948		3,795,207,000
Total proved reserves as of December 31, 1947 plus new proved reserves added in 1948		25,282,892,000
Less production during 1948*		2,002,448,000
Total proved reserves of crude oil as of December 31, 1948		23,280,444,000
Increase in crude oil reserves during 1948		1,792,759,000
NATURAL GAS LIQUIDS		
Total proved reserves of natural gas liquids as of December 31, 1947		3,363,975,000
Revisions of previous estimates and extensions of old pools	+406,874,000	
New reserves (new pools) discovered in 1948	64,683,000	
Proved reserves added in 1948		470,557,000
Total proved reserves as of December 31, 1947 plus new proved reserves added in 1948		3,734,532,000
Less production during 1948*		193,749,000
Total proved reserves of natural gas liquids as of December 31, 1948		3,540,783,000
Increase in Natural Gas Liquids reserves during 1948		286,808,000
TOTAL LIQUID HYDROCARBONS		
Total proved reserves as of December 31, 1947		34,741,660,000
Revisions of previous estimates and extensions of old pools	+3,804,600,000	
New reserves (new pools) discovered in 1948	461,164,000	
Proved reserves added in 1948		4,265,764,000
Total proved reserves as of December 31, 1947, plus new proved reserves added in 1948		39,007,424,000
Less production during 1948*		2,186,197,000
Total proved reserves of liquid hydrocarbons as of December 31, 1948		26,821,227,000
Increase in Total Liquid Hydrocarbon reserves during 1948		2,079,567,000

Summary of U. S. Reserves of Natural Gas
(Thousands of Cubic Feet)

Total proved reserves as of Dec. 31, 1947	165,926,914,000
Extensions and revision of previous estimate	9,769,483,000
New reserves discovered in 1948	4,129,089,000
Net changes in "stored gas" during 1948	51,452,000
Total proved reserves added and net changes in "stored gas" during 1948	13,950,054,000
Total proved reserves as of Dec. 31, 1947 and additions during 1948	179,876,968,000
Deduct production during 1948	6,007,628,000
Total proved reserves of natural gas as of Dec. 31, 1948	173,869,340,000

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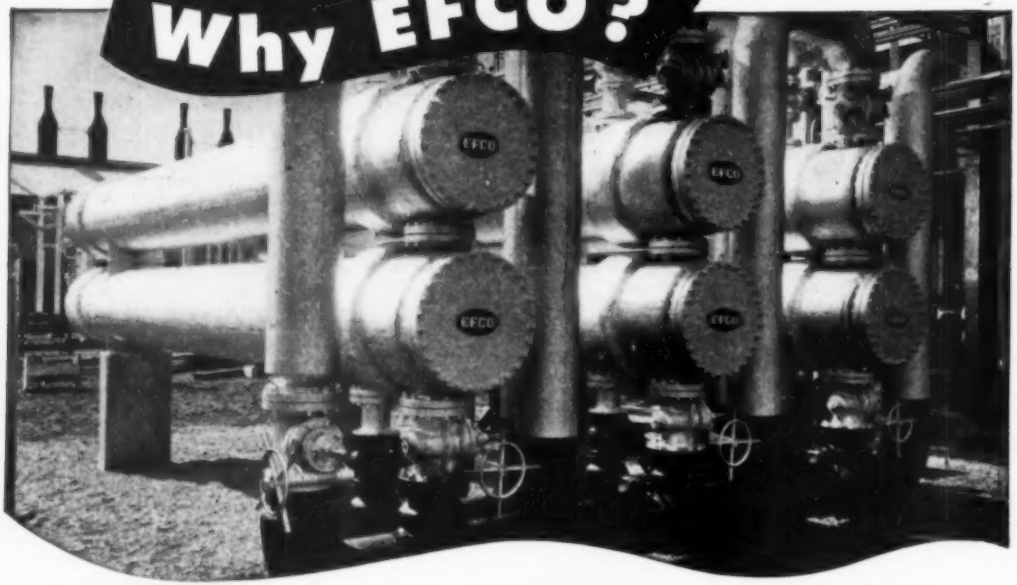

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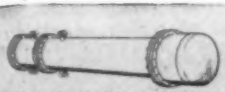

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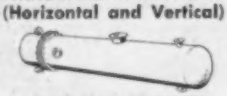

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Companies whose projects are not listed or readers who know of projects not listed are urged to: 1) send in data, as called for by column headings, on units not shown herein; 2) furnish details which are missing in any items in the current tabulation, and 3) report from time to time on the progress of these projects. Address, Editor, PETROLEUM REFINER, Box 2608, Houston 1, Texas. Such cooperation will be very much appreciated.

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
Esso Standard Oil	Linden, N.J.	Vac. pipe still	40,000 bbls.		Under Constr.	1st Qtr., 1949		S.O.D. & Braun	Braun
Esso Standard Oil	Linden, N.J.	Cat. Crack, Light Ends	41,000 bbls.		Under Constr.	2nd Qtr., 1949		S.O.D., Braun	Braun
Esso Standard Oil	Bayonne, N.J.	Dewaxing	7,500 bbls.		Under Constr.	1st Qtr., 1950	Texaco	Badger	Badger
Esso Standard Oil Co.	Linden, N.J.	Steam Boiler	260,000 lbs. hr.		Under Constr.	1st Qtr., 1949		S. O. D.	
Esso Standard Oil Co.	Bayonne, N.J.	Steam Boilers	400,000 lbs. hr.		Under Constr.	2nd Qtr., 1950		S. O. D., Day & Zimmermann	S. O. D., Day & Zimmermann
Gulf Oil Corp.	Philadelphia, Pa.	Topping and Vacuum Unit	30,000 bbls.		Under Constr.	Nov., 1949		Lummus, Badger	Lummus
Socony - Vacuum Oil Co., Inc.	Paulsboro, N.J.	Crude, Dist. Unit	19,500 bbls.		Under Constr.	Mid 1949		Badger	Badger
Socony-Vaccum	Paulsboro, N.J.	Propane Deasphalting	5,950 bbls.		Under Constr.	Mid 1949	Juik	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Furfural Refg.	4,450 bbls.		Under Constr.	Mid 1949	Texaco	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	MEK Dewaxing	2,050 bbls.		Under Constr.	Mid 1949	Texaco	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Clay Contact Unit	3,000 bbls.		Designing	Late 1949		Badger	Badger
Socony-Vacuum Oil Co., Inc.	Paulsboro, N.J.	Light Oil Treating Plant	28,000 bbls.		Designing	Mid 1949		Badger	Badger
L. Sonneborn Sons, Inc.	Petrolia, Pa.	Enlarge Anti-Pollution		$400,000	Under Constr.	Middle 1949		Chemical Constr. Co.	Morris Knowles & Co.
Sun Oil Co.	MarcusHook,Pa.	Wax			Under Constr.	July, 1949	Texaco	Staff	Staff
Sun Oil Co.	Marcus Hook	Comp. & Pkg.			Under Constr.	August, 1949		Staff—Lindsay	W. W. Lindsay
The Texas Co.	Beacon, N.Y.	Expand Research Labs.			Under Constr.	Oct. 1, 1949		Voorhees, Walker, Foley & Smith	
The Texas Co.	Westville, N.J.	New Refinery	40,000 bbls.		Under Constr.	July, 1949		Foster-Wheeler, Jackson-Moreland, Kellogg	Foster-Wheeler, Kellogg
U.S. Dept. of Interior	Bruceton, Pa.	Fischer-Tropsch Pilot Plant (Coal-to-gasoline synthesis)	1-2 bbls.	$150,000	Under Constr.	June, 1949		Staff	Blaw-Knox Co.
MID-CONTINENT									
Ashland Oil & Refining Co.	Canton, Ohio	Ref. Modernization			Under Constr.	Middle 1949			Cat. Constr.
Ashland Oil & Refining Co.	Ashland, Ky.	Revision & Modernization of Refg. Units		$500,000		Completed		Staff	Staff, Cat. Constr.
The Carter Oil Co.	McKamie, Ark.	Pressure Maintenance Unit	38,000 mcf		Under Constr.	July, 1949		J. & L. Constr.	J. & L. Constr.
Cities Service Oil Co.	Chicago	Compounding & Grease Plant	1,200 bbls.	$2.5 million	Design	Late 1949		Sumner-Sollitt	
Cooperative Refinery Association	Coffeyville, Kansas	Dewaxing	2,200 bbls.	$1.5 million	Contracted	1949	Texaco	Process Eng.	Process Eng.
Cooperative Refinery Assoc.	Coffeyville, Kansas	Modernize Gasoline Plant	20,000 bbls.	$900,000	Under Constr.	June, 1949	U.O.P.	U.O.P., Staff	Staff
Continental Oil Co.	Ponca City Oklahoma	Crude Dist. Unit	30,000 bbls.		Under Constr.	Oct., 1949		Bechtel	Bechtel
Dewese Oil Co.	Weston, Ohio	Lube Filtering Unit, Desalting	250 bbls.	$15,000	Under Constr.	Spring, 1949		Staff	Staff
The Globe Oil & Refining Co.	Lemont, Ill.	Cat. Cracker Unit	6,000 bbls.	$1 million	Buying Material	Jan. 1, 1950	U.O.P.	U.O.P.	
*Gulf Oil Corp.	Kiefer, Okla.	Expand Gasoline Plant	14,500 mcf		Under Constr.				
Gulf Refg. Co.	Toledo, Ohio	Top & Vac. Unit	32,000 bbls.			Completed		Badger	Badger
Gulf Refg. Co.	Toledo, Ohio	Fluid Cat. Crk.	15,500 bbls.		Under Constr.	Sept., 1949		Kellogg	Kellogg
Gulf Refg. Co.	Toledo, Ohio	Poly Unit	5,000 bbls.		Under Constr.	Aug., 1949	U.O.P.	Kellogg	Kellogg
Gulf Refg. Co.	Cincinnati, Ohio	Fluid Cat Cracker Unit	15,500 bbls.		Under Constr.	Oct., 1949		Kellogg	Kellogg
Gulf Refg. Co.	Cincinnati, Ohio	Poly Unit	5,000 bbls.		Under Constr.	Sept., 1949	U.O.P.	Kellogg	Kellogg
Hiwan Oil Co.	Magnolia, Ark.	Gasoline Plant	10,000 mcf			Completed		Delta	Delta
Lion Oil Co.	El Dorado, Ark.	Enlarge Ammonia Unit	570 tons	$3.5 million	Under Constr.	June, 1949		Chem. Constr.	Chem. Constr.

• CONTINUED ON NEXT PAGE

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licenser	Engineering	Contractor
Lion Oil Co.	El Dorado, Ark.	Sulfuric Acid Plant	200 tons	$1¼ million	Under Constr.	Sept., 1949		Chem. Constr.	Chem. Constr.
Lion Oil Co.	El Dorado, Ark.	Ammonium Sulfate Plant	380 tons	$750,000	Under Constr.	Sept., 1949		Chem. Constr.	Chem. Constr., Blaw-Knox
M. F. A. Oil Co.	Chanute, Kans.	Desulfurization	1,000 bbls.	$75,000	Under Constr.	June, 1949	Phillips	Koch	Staff
Magnolia Pet. Co.	Grant County, Kans., (Hickok)	Gasoline Plant	100,000 mcf		Buying Material	Nov., 1949		Staff	Waleo
Magnolia Pet. Co.	Grady County, Oklahoma	Gasoline Plant	25,000 mcf		Design	Jan., 1950		Staff	
Magnolia Petroleum Co.	Stephens County, Okla.	Gasoline Plant	30,000 mcf		Under Constr.	Jan., 1950		Staff	J. & L. Constr.
Mercury Oil Refining Co.	Oklahoma City, Oklahoma	Crude Unit	3,500 bbls.	$250,000	Under Constr.	Dec., 1949		Ref. Eng.	Ref. Eng.
Midland Cooperative Wholesale	Cushing, Okla.	Cat. Poly Unit	200 bbls.		Authorized	Middle, 1949			Ref. Eng., U.O.P.
Ohio Oil Co.	Robinson, Ill.	Vac. Unit Cat. Crack, Crude Still, Poly, LP G Recovery	27,500 bbls.	$15 million	Under Constr.	Early, 1949	U.O.P.	McKee	McKee, Pritchard
Petco Corp.	Blue Island, Ill.	Houdriflow Cat. Cracker Unit, LPG Recovery System	5,000 bbls.	$400,000	Under Constr.	Last Quarter, 1949	Houdry	Houdry	Clark's
Phillips Pet. Co.	Kansas Cy, Kans.	Cat. Crack	24,000 bbls.		Under Constr.	Oct., 1949		Braun	Braun
Phillips Pet. Co.	Kansas Cy, Kans.	Cat. Poly	1,500 bbls.		Under Constr.	Oct., 1949		Braun	Braun
Phillips Pet. Co.	Guymon, Okla.	Absorption Plant	173,000 mcf		Under Constr.	July, 1949			
The Pure Oil Co.	Toledo, Ohio	Revamping Crude Reforming Units			Under Constr.	1st Qtr., 1949			Cat. Constr.
R. J. Oil & Refining Co., Inc.	Princeton, Ind.	Electric Desalter	1500 bbls.	$15,000	Under Constr.		Petro	State Eng.	State Eng.
Rock Island Refg. Corp.	Rock Island, Ind.	Fluid Cat. Crk.	10,000 bbls.	$1,200,000	Contracted	July, 1949	U.O.P.	U.O.P.	Staff
The Shallow Water Refining Co.	Shallow Water, Kansas	Reforming Unit	1,250 bbls.	$85,000	Under Constr.	Fall, 1949	Perco	Koch Eng.	Koch Eng.
Skelly Oil Co.	Eldorado, Kans.	Crude Dist. Unit, Cat. Crk.	35,000 bbls.		Under Constr.	Mid 1950			
Socony-Vacuum	E. St. Louis, Ill.	Crude Distillation	15,000 bbls.		Under Constr.	Aug., 1949		Bechtel, Staff	Bechtel
Socony-Vacuum Oil Co.	East St. Louis, Illinois	Thermal Cracking, Reforming, Visbreaker Unit	13,200 bbls.		Under Constr.	Dec., 1949		Staff, Bechtel	Bechtel
Socony-Vacuum Oil Co.	East St. Louis, Illinois	Tannin Sulfuizer Treating Unit	15,000 bbls.		Under Constr.	June, 1949		Staff, Bechtel	Bechtel
Socony-Vacuum Oil Co.	East St. Louis, Illinois	Misel. Refinery Additions			Under Constr.	Sept., 1949		Staff, Bechtel	Bechtel
Socony-Vacuum Oil Co.	East St. Louis, Illinois	Delayed Coking Unit	8,000 bbls.		Under Constr.	Oct., 1949		Staff, Bechtel	Bechtel
Standard Oil Co., (Ohio)	Lima, Ohio	Lube Oil Solvent, Refining Plant	76,000 gals.	$13 million	Contracted	1951		Kellogg Lummus	Kellogg Lummus
Standard Oil Co., (Ohio)	Lima, Ohio	Cat. Cracking	16,000 bbls.	$11 million	Under Constr.	Late 1949	U.O.P.	McKee	McKee
Standard Oil Co., (Ohio)	Lima, Ohio	Crude Distl., Coke	†15,000 bbls.	$5 million	Authorized	Mid 1950	Kellogg	Kellogg	Kellogg
Standard Oil Co., (Ohio)	Lima, Ohio	Solvent Extraction Dewaxing Unit	1,800 bbls. Finished Products		Authorized	Mid 1950	Texaco		Lummus
Standard Oil Co., (Ohio)	Lima, Ohio	Vacuum Unit	9,000 bbls.		Authorized	Mid 1950			Lummus
Standard Oil Co., (Ohio)	Lima, Ohio	Propane Deasphalting Unit	800 bbls.		Authorized	Mid 1950			Lummus
Sun Oil Co.	Toledo, Ohio	Cat. Crack, Crude Dist., Vac., Poly	30,000 bbls.	$16 million	Under Constr.	Jan., 1950	Houdry	Houdry, Cat. Constr., Process Eng., Staff	Cat. Constr.
Sun Oil Co.	Toledo, Ohio	Anti-Pollution	900,000		Under Constr.	June, 1949		Sun Oil	Cat. Constr.
The Texas Co.	W. Tulsa, Okla.	Crude and Cat. Cracking	30,000 bbls.		Under Constr.	July 1, 1949		Kellogg, Foster-Wheeler, U.O.P.	Kellogg, Foster-Wheeler
The Texas Co.	Lawrenceville, Illinois	Expand Refinery	†20,000 bbls.		Proposed	Jan. 1, 1951			
Tide Water Associated Oil Co.	Drumwright, Oklahoma	Houdriflow Unit Cat. Cracker	4,500 bbls.		Contracted		Houdry		Process Eng.
U.S. Dept. of Interior	Louisiana, Mo.	Demonstration Oil-from-Coal Plant	75 bbls.	$4.4 million	Under Constr.	Oct., 1949		Koppers	Koppers
*West Cement Merdrano Unit	Caddo County, Oklahoma	Gas Injection Facility	9000 mcf	$1 million	Under Constr.	June, 1949		Dresser	Dresser
Wood River Oil & Refining Co., Inc.	Hartford, Ill.	Vacuum Unit	18,000 bbls.	$700,000	Under Constr.	June, 1949		Koch	Staff
Wood River Oil & Refining Co., Inc.	Hartford, Ill.	Fluid Cat. Cracker	7500 bbls.	$2.5 million	Under Constr.	Dec., 1949	U.O.P.	Koch	Staff
SOUTHWEST									
The Atlantic Refining Co.	Block 31, Crane County, Texas	Gas Injection Plant	9,320 mcf		Under Constr.	May, 1949		Hudson, Staff	Hudson
The California Co.	Brookhaven, Mississippi	Cycling Plant	10,000 mcf		Designing	3rd Qtr., 1949		Hudson	Hudson
*Barnsdall Oil Co.	Placedo, Tex.	Compressor Station	2000 hp.	$380,000	Under Constr.	May, 1949		Olsen	Olsen
*Barnsdall Oil Co.	Bloomington, Tex.	Compressor Station and Dehydration Plant	600 hp. 10,000 mcf	$285,000		Completed		Olsen	Olsen
Calumet Ref. Co.	Princeton, La.	Blending Oil Tank House	700 bbls.		Under Constr.	3rd Qtr., 1949			Staff
Carthage Corp.	Carthage Field	Gasoline Plant	250,000 mcf	$3.5 million	Under Constr.	April, 1949		Hudson	Hudson
Carthage Hydrocol, Inc.	Brownsville, Texas	Hydrocol	87,000 mcf	$26 million	Under Constr.	Aug., 1949	Hydro-Res., Inc. Texaco	McKee, Hydro-Res., Inc.	McKee
The Chicago Corp.	Carthage, Texas	Enlarge Gas Plt	210,000 mcf	$2 million	Under Constr.	June, 1949		Fish Eng.	Fish Eng.
Cit-Con Corp.	Lake Charles, La.	Lube Plant	6,000 bbls.	$35 million	Under Constr.	Oct., 1949	Texaco, Max B. Miller	Max B. Miller, Lummus	Lummus, Max B. Miller
Cities Service Oil Co.	Pampa, Texas	Gasoline Plant	18,000 mcf		Contracted	1949		Waleo	Waleo
Cities Service Oil Co.	Chico Field, Wise Co., Tex.	Natural Gasoline Plant	22,000 mcf		Planned	Early, 1950			
Claiborne Gasoline Co.	Lisbon, La.	Enlarge Gasoline Plant	125,000 mcf		Under Constr.	April, 1949		Pet. Eng.	
Continental Oil Co.	Todd (Deep) Field, Texas	Gas Recovery Plant	10,000 mcf		Under Constr.	Sept., 1949		Ref. Maint.	Ref. Maint.
Cosden Pet. Corp.	Big Spring, Tex.	Fluid Cat. Plant	6,000 bbls.	$2 million	Under Constr.	Nov., 1949	U.O.P.	U.O.P.	Ref. Eng
*Department of the Army	Houston, Tex.	Anhydrous Ammonia Facility	2100 tons	$2.5 million	Rebuilding	Sept., 1949		Girdler Corp.	Hercules Powder Co.

■ CONTINUED ON PAGE 102

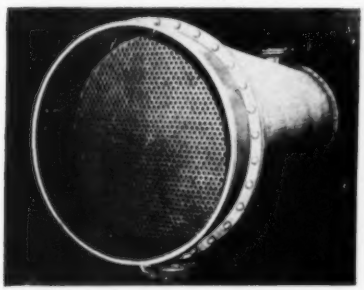
Cupro Nickel Condenser Tubing

Offers Many Advantages for Chemical and Petroleum Plants

In the rapidly expanding chemical, petro-chemical and petroleum refining industries, there is increasing demand for more corrosion-resistant tubing which will stand up under continuous operation in condensers, heat exchangers and pipe lines.

Although tubing of copper, brass, and bronze is successfully and widely used in most applications in these fields, there are special cases which require other types of corrosion-resisting alloys. Among these Cupro Nickel is fast gaining popularity because of its fine characteristics.

Properties of Cupro Nickel. Cupro Nickel, containing 70% copper, 30% nickel and approximately 0.5% iron, is considered the most corrosion-resistant and is most widely used. Cupro Nickel containing 80% copper, 20% nickel and approximately 0.5% iron is next in corrosion resistance. Recently an alloy containing 90% copper and 10% nickel, with 0.7% to 1.0% iron, has been developed, and is beginning to replace some of the other copper-base alloys in certain applications. The United States Navy specifies 70-30 Cupro Nickel for war vessels because of its excellent performance with clean sea water.



Duplex Tubing is used in this condenser, steel to the organic vapor side and a copper-base alloy to the water side. Courtesy Struthers Wells Corporation, Warren, Pennsylvania.

Cupro Nickel also withstands higher temperatures and pressures than most other copper-base alloys, which explains its use in feed water heaters. It leads the other copper-base alloys in resistance to stress corrosion or season cracking associated with the presence of moist ammonia gas.

Offsetting Destruction From Impingement Corrosion. The trend toward faster cooling of various liquids, vapors and gases, and greater velocities of cooling waters and liquids has increased damage from impingement corrosion and erosion. Since Cupro Nickel is superior to most other alloys in resisting this type of attack, we find it being specified where other metals fail prematurely.

Resistance to Ammonia. Because Cupro Nickel withstands attack from ammonia and other nitrogen compounds better than brass, it is being used where the presence of even small amounts of ammonia may contribute toward stress corrosion, season cracking or general corrosion. Where the water supply contains a high percentage of nitrogen-bearing substances, such as sewage, algae, etc., these may be responsible for the presence of ammonia in steam made from such waters.

For ammonia refrigeration systems steel stands up very satisfactorily against the ammonia side, but is not able to cope with corrosion from sea water or brine. Here Duplex Tubing is indicated, with steel to the ammonia side and Cupro Nickel to the water side. Cupro Nickel and other copper-base alloys withstand corrosion satisfactorily from such refrigerants as Freon, methane, butane and propane as well as methyl chloride, in the absence of moisture.

Resisting Corrosion From the Product Side. Cupro Nickel is very satisfactory for handling alkaline solutions in the absence of sulfur compounds. Alkali plants have had good results with Cupro Nickel tubing handling sodium chloride solutions in the production of sodium hydroxide and chlorine. It has been successfully used with naphtha and other petroleum products on one side and salt water on the other. In common with many other copper-base alloys, Cupro Nickel is satisfactory for use with a number of compounds such as acetic acid and acetates, aqueous hydrofluoric acid solutions, non-oxydizing salt solutions and gases such as fluorine, hydrogen, nitrogen, oxygen, and anhydrous hydrogen fluoride.

Consult Laboratory. No one alloy is best for all types of corrosive attack. Bridgeport manufactures a wide range of corrosion-resistant alloys, and the laboratory will be glad to assist in the selection of the one which will serve best. Contact the nearest Bridgeport office, and write for 120-page Condenser Tube Manual, containing much corrosion data, information about condenser tube alloys, valuable tables and other data.

• • •

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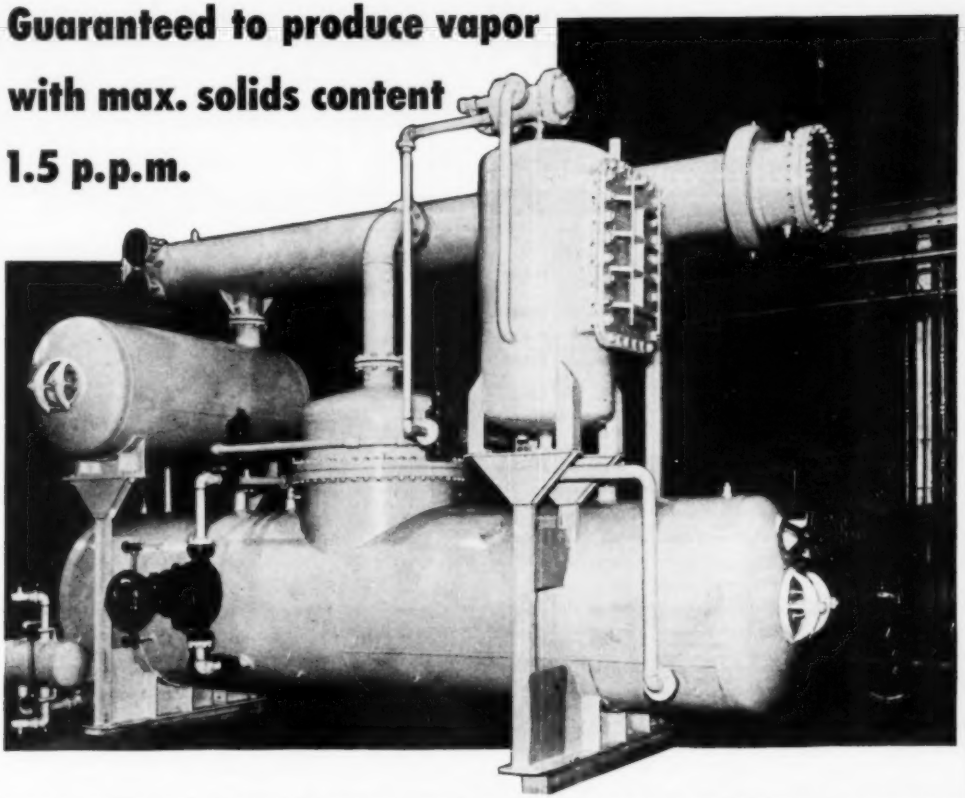
CONDENSER AND HEAT EXCHANGER TUBING

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
E. I. duPont de Nemours Co., Inc.	Victoria Tex.	Chemical Intermediates for Nylon	.....	.....	Design	Early 1951	.....	Staff	Staff
Esso Standard Oil Co.	Baton Rouge, La.	Light Ends Recovery	20,000 mcf	.....	Under Constr.	1st Qtr., 1949	.....	S.O.D., McKee	McKee
Esso Standard Oil Co.	Baton Rouge, La.	Light Ends	11,000 bbls.	.....	Under Constr.	1st Qtr., 1949	.....	Braun	Braun
Ethyl Corp.	Baton Rouge, La.	Mfg. Facilities	.....	$40 million	Under Constr.	Oct., 1949	.....	Stone & Webster	Stone & Webster
Gray-Wolfe Co.	Montgomery Co.	Gasoline Plant	13,000 mcf	$2 million	Under Constr.	Oct, 1949	.....	O. L. Olsen	O. L. Olsen
Gulf Oil Corp.	Crane, Texas	Gasoline Plant	40,000 mcf	.....	Under Constr.	July, 1949	.....	Braun	Braun, W. D. Bowden
Humble O&R Co.	Katy, Texas	Add Propane, Absorption, refrigeration	Unchanged	$7 million	Under Constr.	Oct., 1949	.....	Stearns-Roger	Stearns-Roger
Humble O&R Co.	Kelsey Field, Texas	Gas Injection Plant	18,000 mcf	$1,408,000	Under Constr.	May, 1949	.....	Stearns-Roger	Stearns-Roger
Humble O&R Co.	Conroe, Texas	Add Absorption	30,000 mcf	$4,180,000	Under Constr.	Summer, 1949	.....	Stearns-Roger	Stearns-Roger
Humbe O&R Co.	Heyser Field Texas	Gas Comp. Plant	23,000 mcf	.....	Under Constr.	April, 1949	.....	Belleo Ind. Piping Co.	Belleo Ind. Piping Co.
Humbe O&R Co.	Opelousas, La.	Absorption Plant	110,000 mcf	$2,800,000	Under Constr.	Summer, 1949	.....	Hudson	Hudson
Humble O&R Co.	Fickton Fiekl, Texas	Absorption Plant	18,000 mcf	$2,133,000	Under Constr.	June, 1949	.....	Fluor	Fluor
Humble O&R Co.	Baytown, Texas	Pipe Stills	45,000 bbls.	$5.8 million	Under Constr.	Late 1949	.....	Foster-Wheeler	Foster-Wheeler
Humble O&R Co.	Baytown, Texas	Lube Extraction	7,000 bbls.	$5.2 million	Under Constr.	Late 1949	.....	Kellogg	Kellogg
Humble O&R Co.	Flour Bluff Field, Texas	Compression Plant	12,000 mcf	.....	Under Constr.	April, 1949	.....	Tellepsen	Tellepsen
Humble O&R Co.	Imogene-Jourdanton-Charlotte Fields, Texas	Compression Absorption Plt.	26,000 mcf	.....	Contracted	1949-1950	.....	.....	Hudson
Humble O&R Co.	Thompsons, N. Thompsons, S. Thompsons Field, Texas	Gas Compression Plant	18,800 mcf	.....	Under Constr.	June, 1949	.....	Brown Eng.	Brown Eng.
Hutex Oil & Refining Co.	Hardin, Tex.	Fractionators for Solvents	1,000 bbls.	$30,000	Buying Materials	July, 1949	.....	Staff	Staff
Jefferson Chem. Co.	Austin, Texas	Central Research Facilities	.....	.....	Under Constr.	Sept., 1949	.....	Staff	Staff
La Gloria Corp.	Falfurrias, Tex.	Casinghead Gas	20,000 mcf	.....	Under Constr.	May, 1949	.....	Hudson	Hudson
Lone Star Gas	Dallas, Texas	Hypersorption Plant	60 mcf	.....	Design & E ng.	1949	Union Oil Co.	Foster-Wheeler	Foster-Wheeler
Magnolia Pet. Co.	Seeligson Field, Texas	Gasoline and Cycling	70,000 mcf (Casinghead 150,000 mcf (Cycled	.....	Under Constr.	Sept., 1949	.....	Hudson	Hudson
Magnolia Pet. Co.	Kilgore, Texas	Increase Propane Recovery	Unchanged	.....	.....	Completed	.....	Staff, Delta	Delta
Midland Gasoline Co.	Conroe Field, Texas	Enlarge Gasoline Plant	100,000 gals.	.....	Under Constr.	Dec., 1949	.....	Gaso. Plant	Gaso. Plant
*Monsanto Chemical Co.	Columbia, Tenn.	Smoke Washing Unit	.....	$750,000	Under Constr.	June, 1949	.....	Staff	Rust Eng.
Nueces Corp.	Agua Dulce Field, Texas	Gas Compression	.....	.....	Under Constr.	April, 1949	.....	.....	.....
Odessa Natural Gasoline Co.	Odessa, Texas	Enlarge Gasoline Plant	65,000 gals.	$1 million	Under Constr.	May, 1949	.....	J. & L. Constr.	J. & L. Constr.
Pan American Refining Corp.	Texas City, Texas	Expand Chemical Research Facilities	.....	.....	Contracted	Jan., 1950	.....	Staff, H. K. Ferguson	Staff, H. K. Ferguson
Pan American Refining Corp.	Texas City, Tex.	Revamping Crude Unit	.....	.....	Engineering	Late 1949	.....	Tellepsen	Tellepsen
Panhandle Producing & Refg. Co.	Wichita Falls, Texas	Cat. Cracker	1,500 bbls.	$1 million	Engineering	March, 1950	U.O.P.	U.O.P., J. & L. Constr.	J. & L. Constr.
The Parade Co.	Rusk County, Texas	Add Propane Recovery	18,000 mcf	$250,000	Under Constr.	April, 1949	.....	Hudson	Hudson
Petrol Refining, Inc.	Texas City, Texas	Crude Topping Units	50,000 bbls.	.....	Under Constr.	May 15, 1949	.....	Rust. Eng.	Rust. Eng.
*Phillips Chemical Co.	Etter, Tex.	Anhydrous Ammonia	70,000 tons year	$5.3 million	Under Constr.	July, 1949	Chem Constr.	Chem. Constr.	Brown & Root
Phillips Pet. Co.	Goldsmith, Tex.	Add to Absorption Plant	40,000 mcf	.....	.....	Completed	.....	.....	.....
Plymouth Oil Co.	Rankin, Texas	Gas Compression, Absorp.	70,000 mcf	$3½ million	Under Constr.	1949-50	.....	.....	Hudson
The Pure Oil Co.	Nederland, Tex.	MEK Deoiling	200 bbls.	.....	Under Constr.	Sept., 1949	Texaco	Lummus	Lummus
Reichhold Chemicals, Inc.	Houston, Texas	Synthetic Resins Plant	.....	$500,000	Projected	.....	.....	.....	.....
Royal Pet. Co.	Corpus Christi, Tex.	Modernize Refinery	.....	$3 million	Under Constr.	.....	.....	.....	.....
Shamrock Oil & Gas Co.	Sunray, Texas	Increase Topping & Cracking Facilities	10,000 bbls.	$300,000	Under Constr.	3rd Qtr., 1949	U.O.P.	Staff	Staff
*Shamrock Oil & Gas Co.	Sunray, Tex.	Gas-Compressor Unit	2900 hp.	$500,000	Under Constr.	July, 1949	.....	Staff	Staff
Shell Chem. Co.	Houston, Texas	Extend Acetone Facilities	.....	.....	Under Constr.	Late 1949	.....	Braun	Braun
*Shell Oil Co.	Provident City, Tex.	Gas Stripping Plant	60,000 mcf	.....	Projected	1st qtr., 1950	.....	Staff	.....
Shell Oil Co.	Nottres, Texas	Extension TXL Plant	30,000 mcf	.....	Under Constr.	Early 1950	.....	Brown & Root	Brown & Root
Shell Oil Co.	Denver City, Texas	Gas Compression, Absorp. Addition	30,000 mcf	.....	Under Constr.	Late 1949	.....	Fluor	Fluor
Sinclair Prairie Oil Co.	Midway Lane Field, Texas	Gas Compression	.....	.....	Under Constr.	Early, 1949	.....	.....	.....
Shelly Oil Co.	Shellytown, Tex.	Expand Gasoline Plant	.....	.....	Under Constr.	Fall, 1949	.....	.....	J. E. Carlson
Southern Minerals Corp.	Stratton Field, Texas	Gas Compression Addition	.....	.....	Under Constr.	1st Qtr., 1949	.....	.....	.....
Standolind O&G Co., Ope	Fullerton Field, Texas	Gasoline Plant	55,000 mcf	.....	Under Constr.	Jan., 1950	.....	J. & L. Constr.	J. & L. Constr.
Standolind O&G Co.	Brownsville, Tex.	Chemical Plant	130,000 lbs./yr.	.....	Under Constr.	Jan. 1, 1950	.....	Badger	Badger
Standolind O&G Co.	Pettus, Texas	Cycling Plant	166,000 mcf	.....	Under Constr.	May 1, 1949	.....	J. & L. Constr.	J. & L. Constr
Standolind O&G Co.	Levelland Field, Texas	Gasoline Plant	.....	.....	Planned	1950	.....	Brown & Root	Brown & Root
Standolind O&G Co.	N. Cowden, Tex.	Gasoline Plant	75,000 mcf	.....	Engineering	1950	.....	Stearns-Roger	Stearns-Roger
Sun Oil Co.	Starr Co., Texas	Gasoline Plant	35,000 mcf	$4 million	Under Constr.	May, 1949	Pet. Eng.	Pet. Eng.	Pet. Eng.
Sun Oil Co.	Jameson Field, Coke County Texas	Gasoline Plant	10,000 mcf	Part of $12 million	Under Constr.	June, 1949	.....	Pritchard	Pritchard
Tex. Natl. Gas Corp. & Slick-Urschel Oil Co.	Rankin, Tex.	Gasoline Plant	55,000 mcf	.....	Under Constr.	Late 1949	.....	Tex. Natl. Gas Corp.	Tex. Natl. Gas Corp.

* CONTINUED ON PAGE 104

Guaranteed to produce vapor with max. solids content 1.5 p.p.m.



LUMMUS UNIT ALSO SAVES SPACE, FOUNDATIONS, AND STRUCTURAL SUPPORTS

In designing and building this package unit for the Rockland Light and Power Company's Hudson plant, Lummus kept it within space limitations by mounting the deaerating feed preheater, the evaporator condenser, the condensate receiver, and the control equipments all on common supports with the evaporator.

The effective tube surface is 478 sq. ft.

The unit is guaranteed to produce vapor with a solids content of not more than 1.5 p.p.m when the total solids in the shell liquid is maintained at 3,000 p.p.m. This vapor purity is assured by Lummus' steam scrubber, which can produce purity of 1 p.p.m.

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REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
The Texas Co.	Port Arthur, Texas	Lube & Wax Additions	†37,500 Crude †2,500 bbls. Oil		Under Constr.	April 1, 1949		Foster-Wheeler	Foster-Wheeler
The Texas Co.	Port Arthur, Texas	Change to Linde Solutiner Treating Facilities			Under Constr.	April, 1949		Foster-Wheeler	Foster-Wheeler
The Texas Co.	Ganado Field, Texas	Gas Compression	5,000 mcf			Completed			
The Texas Co.	Tijerina-Canales Field, Texas	Gas Compression	6000 mcf		Under Constr.	Oct., 1949			
The Texas Co.	Chalk-Hill Field, Texas	Gas Compression, Absorp.	2000 mcf		Under Constr.	August, 1949			
*The Texas Co.	Withers Field, Tex.	Expand Compression	9000 mcf		Under Constr.	July, 1949		Tellepsen	Tellepsen
United Gas Co.	Carthage, Texas	2nd Gas Plant	100,000 mcf	$3.5 million	Under Constr.	July, 1949		Hudson	Hudson
U.S. Ind. Chemicals Co.	Brownsville, Texas	Petrochemical Plant			Contracted	1949		Badger	Badger
ROCKY MOUNTAIN									
American Gilsonite Co. Co.	Bonanza, Utah	Gilsonite to Crude Oil Pilot Plant	200 tons	$300,000	Engineering	July, 1949		Staff	Staff
The Carter Oil Co.	Billings, Mont.	Crude Cat. Crk.	30,000 bbls.	$20 million	Under Constr.	3rd Qtr., 1949		U.O.P., S.O.D., Fluor	Fluor
Continental Oil Co.	Billings, Mont.	Complete Ref. Cat. Crack	7,500 bbls.	$1 million	Under Constr.	Oct., 1949	U.O.P.	U.O.P., J. & L. Constr.	J. & L. Constr.
Empire State Oil Co.	Thermopolis, Wyoming	Crude, Vacuum Units	5,000 bbls.	$325,000	Engineering Under Way	May, 1949		Ref. Eng.	Ref. Eng.
Gulf Oil Corp.	Eunice, N. M.	Gasoline Plant	50,000 mcf		Under Constr.	June, 1949		Hudson	Hudson
New Mexico Asphalt Refg. Co.	Artesia, N. M.	Crude Unit	7,500 bbls.	$350,000	Material being Received	May, 1949		Geo. Armistead	Staff
The Pure Oil Co.	Worland, Wyo.	Gasoline Plant			Projected				
Skelly Oil Co.	Lea County, N. M.	Expanding Gasoline Plant	60,000 gals.		Under Constr.	Mid 1949			J. E. Carlson
Socony-Vacuum	Casper, Wyo.	T C C	6,900 bbls.			Completed		Staff	Cat. Constr.
Southern Union Gas Co.	Bloomfield, N. M.	Gasoline Plant	20,000 mcf	$1 million	Under Constr.	May, 1949		Ref. Maint.	Ref. Maint.
Standard Oil (Ind.)	Casper, Wyo.	Cat. Crack	8,000 bbls.			Completed			Kellogg
Stanolind Oil & G Co.	Elk Basin, Wyo.	Gasoline Plant	12,000 mcf			Completed			Stone & Webster
Texas Gulf Sulphur Co.	Worland, Wyo.	Sulfur Recovery Plant	30,000 mcf		Projected			Stone & Webster	
U.S. Bureau of Mines	Rifle, Colo.	Shale Oil Refy.	300 bbls.	$750,000		Completed		Ref. Eng.	Ref. Eng.
WEST COAST									
Barnsdall Oil Co.	Newhall, Calif.	Gasoline Recovery Unit	40,000 mcf		Under Constr.	June, 1949		Ref. Maint.	Ref. Maint.
General Petroleum Corp.	Torrance, Calif.	TCC Furnace Expansion	4,000 bbls.		Under Constr.	Early 1949		Staff-Lummus	Lummus
Hercules Powder Co.	Hercules, Calif.	Ammonia Plant			Under Constr.	Summer 1949		Staff	Bechtel
Robt. S. Lytle, Opr.	Coalinga, Calif.	H_2S Removal	33,000 mcf	$175,000		Completed	Fluor	Fluor	Fluor
Shell Chem. Corp.	Dominguez, Cal.	Add Acetone			Under Constr.	July, 1949		Braun	Braun
Shell Oil Co.	Wilmington, Cal.	Extend Cracking Plant Compressors			Under Constr.	Middle 1949		Fluor	Fluor
Shell Oil Co.	Wilmington, Cal.	Extend Tank Storage			Under Constr.	Middle 1949		Staff	Chicago Bridge & Iron Co.
Stanoil Asphalt & Bituminals Co.	Portland, Ore.	Asphalt Packing Plant, Warehouse			Under Constr.	June, 1949		Staff	
Standard Oil Co. of Calif.	Bakersfield, Calif.	Crude Dist.	10,000 bbls.	$7.5 million	Under Constr.	Mid 1949	Braun	Braun	Braun
Standard Oil Co. of Calif.	Bakersfield, Calif.	Thermal, Crk., Gaso. Stabil. Gaso. Treating	9,000 bbls.		Under Constr.	Late 1949	U.O.P.	U.O.P.	Braun
Standard Oil Co. of Calif.	El Segundo, Cal.	Cracked Naphtha Rerun Still	22,000 bbls.	$2.6 million	Contract let	Aug., 1949		Braun	Braun
Union Oil Co fo California	Oleum, Calif.	Asphalt Refined Oil Loading Facilities		$457,000	Contracted	1949		Early Constr.	Early Constr.
Union Oil Co. of California	Oleum, Calif.	Revimon of Refining Facilities		$4.2 million	Engineering	1949		Parsons	Ref. Maint.
Union Oil Co. of California	Oleum, Calif.	Revise Lube, Dewax Units	1,900 bbls.	$1.7 million	Contracted	1949	Union Oil Co.	Kellogg	Kellogg
Union Oil Co. of California	Oleum, Calif.	Improvements to Compound & Grease Facilities		$1.2 million	Engineering	1949		J. M. Montgomery & Co.	
Union Oil Co. of California	Oleum, Calif.	Duo-Sol Unit	6,000 bbls.	$2.9 million	Contracted	1949	Max Miller	Max Miller	Max Miller
Union Oil Co. of California	Oleum, Calif.	Tankage and Utilities		$2 million	Contracted	1949		Ehrhart & Arthur	Ref. Maint.
Union Oil Co. of California	Wilmington, Calif.	H_2S Recovery	30,000 bbls.	$200,000	Engineering	1949	No	Ehrhart & Arthur, Inc.	
FOREIGN									
Agwi Pet. Corp.	Fawley, Eng.		120,000 bbls.	$140 million	Projected	1952			
Anglo-Iranian Oil	Abadan, Iran	Gas Plant	25,000 mcf	$2 million	Under Constr.	1950		Badger	Badger
Anglo-Iranian Oil	Abadan, Iran	Cat. Cracker	30,000 bbls.		Under Constr.			Foster-Wheeler	Foster-Wheeler
Anglo-Iranian Oil	Abadan, Iran	Lube Plant	400 bbls.		Under Constr.		Texaco	Badger	Badger
Anglo-Iranian Oil	Isle of Grain, Thames and Medway Estuary, Eng.	Central Refining Unit	60,000 bbls.	$120 million	Planning	1952	Texaco (Lube Unit)		
Anglo-Transvaal Consolidated Investment Co.	Vall River Union, South Africa	Synthetic Gasoline and Diesel Oil Plant		$50-60 million	Contracted			Hydrocarbon Research	
Arabian American Oil Co.	Abqaiq, Saudi Arabia	Crude Oil Stabilizer	300,000 bbls.	$4,800,000	Under Constr.	July-Sept., 1949		Staff and Fluor	Staff and Fluor
Arabian American Oil Co.	Abqaiq, Saudi Arabia	Steam Power Plant, etc.	20,000 kw	$9,400,000	Under Constr.	July-Sept., 1949		Staff and Fluor	Staff and Fluor
Arabian American Oil Co.	Ras Tanura, Saudi Arabia	Add Power Generating Unit	10,000 kw	$1,750,000	Under Constr.	July-Sept., 1949		Staff and Fluor	Staff and Fluor
Arabian American Oil Co.	Ras Tanura, Saudi Arabia	Refinery Additions			Under Constr.	1949		Bechtel	Bechtel
Australian Shell Oil Co.	Geelong, Victoria, Australia	New Refinery		$4.8 million	Under Constr.	1951			
Azienda Generale Italiana Petroli	Rome, Italy	Add to Plant	24,000 bbls.		Projected				

* CONTINUED ON PAGE 106

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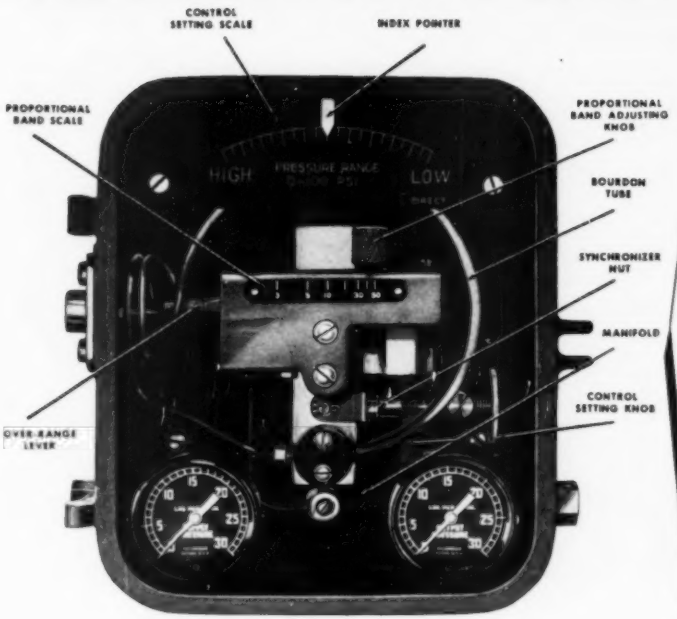

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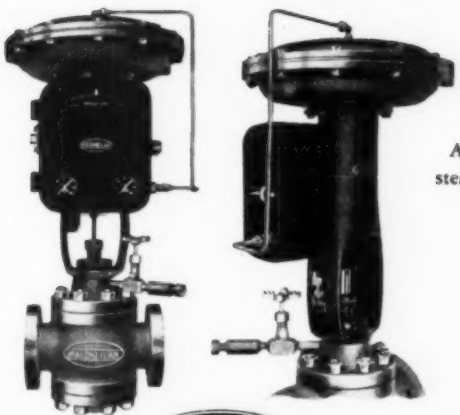

These controllers are designed for many industrial applications requiring accurate control where more expensive instruments are not warranted.

Applications include, among many others, pump governors, steam pressure reducing stations, gas well pressure reduction, etc., requiring small to intermediate proportional band.

The case is rugged and suitable for outdoor service; it is so designed that it may be mounted on the valve (on integral pad or by means of a U-clamp) or, *if the occasion arises, it may be removed from the valve and mounted on a wall.* A flush type case is also available for panel mounting.

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REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Bahrein Pet. Co., Ltd.	Bahrein Island	Expansion Program		$8.3 million	Under Constr.	Oct., 1949		U.O.P., Bechtel	International, Bechtel, Inc.
Bahrein Pet. Co., Ltd.	Bahrein Island	Crude Still, Utilities	55,000 bbls.	$9.1 million	Planned	June, 1950		Lummus, Bechtel	
Batafsche Petroleum Maatschappij	Rotterdam-Pernis, Holland	Dewaxing Unit	60,000 bbls.				Texaco (Dewax)		
British-American Oil Co., Ltd.	Montreal, East P.Q., Canada	Cat. Cracking and Cat. Poly	13,300 bbls.		Under Constr.	August, 1949	Kellogg-U.O.P.	Kellogg	Kellogg
British Pet. Chem., Ltd.	Grangemouth, Scotland	Petro-Chem		$20 million	Planned			S. & W. Badger	S. & W. Badger
Burmah Oil Co.	Burma	Furfural Plant	1,000 bbls.	$600,000	Designing		Texaco	Badger	
Burmah Oil Co.	Syriam, Burma	Thermafor Clay Revivification	66 tons	$150,000	Design	1949	Max Miller, Sunny-Vacuum	Max Miller	
California-Texas Co., Ltd.	Cartagena, Spain	Refinery	15,000-20,000 bbls.		Proposed	March, 1951			
Caltex Pet. Maatschappij, N. V.	Rotterdam, Holland	Complete Refinery	20,000 bbls.	$18 million	Under Constr.	Feb., 1950		McKee, Badger, U.O.P.	McKee
Cie. de Raf nage Shell-Berre	Berre, France	Capacity Increase	47,000 bbls.		Planned				
Cie. Francaise de Raffinage	Gonfreville, France	Lube Unit	2,500 bbls.		Projected	1951			
Cie. Francaise de Raffinage	Gonfreville, France	Distillation Unit	20,000 bbls.		Under Constr.	1950		Foster-Wheeler	Foster-Wheeler
Cie. Francaise de Raffinage	Provence, France	Topping Unit	20,000 bbls.		Under Constr.	1950		Foster-Wheeler	Foster-Wheeler
Cie. Francaise de Raffinage	Provence, France	Lube Oil Unit	2,500 bbls.			1950			
Cie. de Raffinage Shell-Berre	Petit Couronne, France	Lube Unit			Planned				
*Companhia Brasileira de Petroleos S.A.	Rio Grande, Brazil	Topping, Thermal Cracking	3000 bbls.		Authorized	1952	Foster-Wheeler		
Compania Espanola de Petroleos S.A. (C.E.P. S.A.)	Canary Islands, Spain	Lube, Wax Facilities	5,000 bbls.	$41½ million	Under Constr.	Early 1950	Texaco, Standard, N.J.	Foster-Wheeler	Foster-Wheeler
*Conselho Nacional do Petroleo	Mataripe, Bahia, Brazil	Thermal Cracking Refinery	2500 bbls.	$2.5 million	Under Constr.	Jan., 1950		Kellogg	Kellog, Staff
*Conselho Nacional do Petroleo		Thermal Cracking Refinery	45,000 bbls.		Design	1952			Fives, Lille, Schneider, Staff
Consolidated Ref., Ltd.	Haifa, Palestine	Crude Plant	80,000 bbls.		Planned	By 1950		Badger	Badger
Consolidated Ref., Ltd.	Haifa, Palestine	General Facilities			Under Design			Badger, Ltd.	
Consolidated Ref., Ltd.	Haifa, Palestine	Lube Plant	2,500 bbls.		Designing		Texaco, Juik	Lummus, Kellogg	Lummus, Kellogg
Creole Pet. Corp.	Amauy Bay, Venezuela	Crude Stills	60,000 bbls.	$175 million	Under Constr.	1951		S. O. Devel. Co.	Foster-Wheeler, J. G. White
Creole Pet. Corp.	El Roble Field, Venezuela	Reprocessing			Planning				
Egyptian Government	Cairo, Egypt	Crude Plant						Lummus	Lummus
*Excelsior Refineries	Lydminster, Alberta, Canada	Moving Refinery	3000 bbls.	$500,000	Under Constr.	Sept., 1949	U.O.P.	U.O.P.	
Hi-Way Refineries, Ltd.	Saskatoon, Saskatchewan	Crude Topping Unit	2,000 bbls.		Under Constr.			Ref. Eng.	Ref. Eng.
Hi-Way Refineries, Ltd.	Saskatoon, Saskatchewan	Thermal Cracking Unit	500 bbls.		Under Constr.			Ref. Eng.	Ref. Eng.
Imperial Oil, Ltd.	Edmonton, Canada	Increase Capacity	11,000 bbls.	$21½ million	Under Constr.	Sept, 1949		Staff, Barnes	Barnes
Imperial Oil, Ltd.	Leduc Field, Canada	Gas Absorption Plant	24,000 mcf	$6.5 million	Under Constr.	Middle 1950		Braun	Braun
Industrie Chimiche Italiane Petroli	Mantua, Italy	Crude	4,500 bbls.						
Kuwait Oil Co.	Kuwait	Topping Unit	20,000 bbls.	$2 million	Under Constr.	July, 1949		Badger	Badger
Mediterranean Ref. Co.	Trans-Arabian P.L. Mediterranean Term.	Refinery			"Paper Stage"				
Mene Grande Oil Co.	West Guara, Venezuela	Repressuring							
National Oil Refineries, Ltd.	Llandarcy, Wales	Crude and Reform.	40,000 bbls.	$36 million	Designing			Badger	Badger
National Oil Refineries, Ltd.	Llandarcy, Wales	Lubes & Wax	1,200 bbls.				Texaco	Badger	Badger
National Oil Refineries, Ltd.	Llandarcy, Wales	SO_2 Solvent Extracti n	3,000 bbls.		Contracted			H. W. P.	
Pechelbronn S. A. E. M.	Merkwiller, France	Capacity Increase	1,350 bbls.		Authorized	1950			
Petro Carbon, Ltd.	Partington, England	Cat. Cracker Lub & Ref-ery	20,000 bbls.						
Petro Chem., Ltd.	Partington, England	Petro Chemicals							
Petroleos Mexicanos	Poza Rica, Mex.	Gas Purification, Pressure Maintenance, etc.		$13 million	Contracted	Early 1950		McKee	McKee
Petroleos Mexicanos	Salamanca, Mex.	Crude, Gasoil, Cracking	30,000 bbls.	$12 million	Under Constr.	Early 1950	U.O.P.	McKee	McKee
Philblack, Ltd.	Avonmouth, England	Carbon Black Plant	50 million lbs. Yearly	$5 million	Contracted	1950	Phillips	H. W. P.	H. W. P.
Porto Marghera Rfg.	Venice, Italy	Enlarging Crude Unit			Contracted			H. W. P.	H. W. P.
Raffineries de Petrole de la Gironde	Ambes, France	Refinery	13,000 bbls.	$7.8 million	Under Constr.	Early 1950		U.O.P., McKee	McKee
Raffineries Francaises de Petrole de l'Atlantique	St. Nazaire, France	Consolidate Refineries	7,100 bbls.						
Raffineries di Napoli, S. P. A.	Naples, Italy	Topping Unit	10,000 bbls.		Under Constr.	Mid 1949		Staff	Staff
Raffineries di Napoli, S. P. A.	Naples, Italy	Solvent Treating	1,000 bbls.		Under Constr.	Early 1950	Texaco	Staff	Staff
*Refinaria de Petróleo do Distrito Federal S.A.	Rio de Janeiro, Brazil	Complete Refinery	10,000 bbls.		Authorized				
*Refinaria e Exploracao de Petroleo	Capuava, S. Paulo, Brazil	Thermal Cracking Refinery	20,000 bbls.		Authorized			Pan American Hydrocarbon Res., Inc.	Czech, Fact. Metal Work & Mech. Constr.
Richmond Exploration Co.	Lake Maracaibo, Venezuela	New Refinery	35,000 bbls.		Engineering	June, 1950			
Scottish Oil, Ltd.	Grangemouth, Scotland	Crude	28,000 bbls.	$28 million	Designing				Schneider
Scottish Oil, Ltd.	Grangemouth, Scotland	Cat. Crk.	5,000 bbls.		Planned				
Shell Chem. Corp.	Thornton, Eng.	Petro-chem	Several millions	Under Constr.					
Shell Chem. Corp.	Shell Haven, England	Petro-chem							
Shell Chem. Corp.	Stanlow, Eng.	Petro-chem							
Shell Oil Co. of British Columbia	Shellburn Ref., Vancouver	Add Crude Distillation	7,500 bbls.	$600,000		Completed		Staff	Staff

■ CONCLUDED ON PAGE 108

● Experimental laboratory condenser, with water boxes removed, designed by The American Brass Company and tubed with eight different copper alloys, as it appeared after 10-month test, July 28, 1947 to May 25, 1948, at the Marine Test Station of International Nickel Co., at Kure Beach, N. C. *(see above).*

ANACONDA Cupro-Nickel 754

(10 PERCENT NICKEL CONDENSER TUBE)

MANUFACTURED AND SOLD UNDER U. S. PATENT NO. 2,074,604

Shows High Resistance Under Accelerated Test

TEN months of testing with high velocity sea water at Kure Beach, N. C., demonstrate the superiority of Anaconda Cupro-Nickel 754 (nominal composition, copper 89.25 percent, nickel 10 percent, iron .75 percent) over a number of widely used condenser tube alloys.

The purpose of the test was to determine the resistance of various standard tube alloys to corrosion-erosion type of deterioration caused by turbulent flow of sea water. The tubes are .625" O. D., 18 gage (.049"), and 61 inches long. The average velocity of sea water flowing through the tubes, during the continuous 10-month test, was 11.7 feet per second. Water temperature varied from 45°F. to 85°F., according to the season of the year.

This test, and performance records where Cupro-Nickel 754 tubes have been in service under severe operating conditions, indicate that this tube and tube sheet alloy will give economical service for central station and marine condensers handling clean and some types of polluted sea waters. The American Brass Company welcomes opportunities to discuss problems relating to condenser tubes, and the services of its Technical Department are available for assistance in selecting alloys to meet specific operating conditions.

ANACONDA

Anaconda

CONDENSER TUBES

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut

Subsidiary of Anaconda Copper Mining Company

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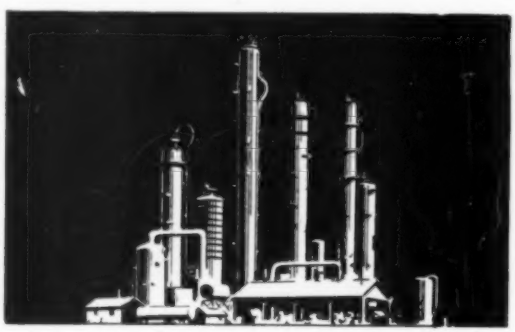
REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Shell Oil Co. (Venezuela)	Puerto Cardon Venezuela	Complete Refg.	50,000 bbls.		Under Constr.	Early 1940		Lummus	Lummus
Shell Oil Co.	Brynham, Eng.	Remodel & Redesign Crude Plant	30,000 bbls.		Under Constr.	Mid 1940			
Société Generale des Huiles de Pétrole	L'Avera, France	LPG and Gas Stabilizing Units			Under Constr.				
Société Generale des Huiles de Pétrole	Dunkirk, France	Crude Reform.	33,000 bbls.		Designing				
Société Generale des Huiles de Pétrole	Dunkirk, France	Lube & Wax	6,700 bbls.		Designing	1950	Texaco		
Societe Industriel Belgique de Petrole	Antwerp, Belgium	Crude, Cracking Reforming	30,000 bbls.		Designing	Mid., 1951			
Societa per Azioni Raffineria Padana Oli i Minerali	San Matrino di Trecate, Italy	Refinery	10,000 bbls.		Proposed				
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Contact Plant			Under Constr.	Mid 1940		Staff	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	MEK Unit	1,000 bbls.		Design	Early 1950	Texaco	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Solvent Treating	1,100 bbls.		Design	Mid 1950	Turk	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Furfural Unit	1,000 bbls.		Under Constr.	Early 1940	Texaco	Staff	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Grease and Compounding Plant			Under Constr.	Early 1950		Staff	Staff
*Socony-Vacuum Francaise	Frontignan, France	Capacity Increase	13,500 bbls.		Under Constr.	Aug., 1940		Staff	Staff
Standard Françaises des Petroles	Port Jerome, France	Capacity Increase	30,000 bbls.		Authorized				
Standard Françaises des Pétroles	Port Jerome, France	Dewaxing Plant	1,000 bbls.		Planned				
Standard Françaises des Pétroles	Port Jerome, France	Desasphalting Plant	2,000 bbls.		Planned				
Stora Kopparberg	Sweden	Crude, Ther. Cracking						Lummus	Lummus
Treat Oil Prod. Development Co.	North Shields, England	Crude Plant	11,500 bbls.	$4 to $8 million	Plans approved				
Union Petrol Refinery, Ltd.	Johannesburg, Union of South Africa	New Refinery		$20 million	Projected				
*Venezuelan Gulf Refining Co.	Puerto la Cruz, Venezuela	Refinery	30,000 bbls.		Under Constr.	July, 1940		Lummus	Lummus
Venezuelan Pet. Co. Sinclair)	Puerto la Cruz, Venezuela	Refinery	35,000 bbls.	..	Under Constr.			Frederick Snare Corp.	Frederick Snare Corp.
Yacimientos Petroliferos Fiscales	Buenos Aires, Argentina	New Refinery	28,000 bbls.		Engineering	Late 1950		Kellogg	Kellogg
Yacimientos Petroliferos Fiscales	La Plata, Argentina	Crude Topping, Gaso Treating	50,000 bbls.	$2.8 million	Under Constr.	Early 1940		Houdry Process Cat. Constr.	Cat. Constr.
Yacimientos Petroliferos Fiscales Bolivianos	Sucre, Bolivia	Crude Plant	3,000 bbls.			2nd Qtr., 1940		Foster-Wheeler	Foster-Wheeler
YPF Bolivianos	Cochabamba Bolivia	Topping & Reforming Units	5,000 bbls.			1st Qtr., 1950	..	Foster-Wheeler	Foster-Wheeler

* First appearance in tabulation. † Added capacity.

Note—Badger—E. B. Badger and Sons Barnes—W. M. Barnes & Co. Bechtel—Bechtel Corp. Bellows—W. S. Bellows Co. Braun—C. F. Braun Co. Brown Eng.—Brown Engineering Co. Brown & Root—Brown & Root Construction Co. Cat. Constr.—Catalytic Construction Co. Chem. Constr.—Chemical Construction Co. Clark's—Clark's Construction and Engineering Co. Delta—Delta Engineering Co. Dresser—Dresser Engineering Corp. Fish Eng.—Fish Engineering Corp. Fluor—Fluor Corp. Foster-Wheeler—Foster-Wheeler Corp. Gaso. Plant—Gasoline Plant Construction Co. General American—General American Transportation Co. Houdry—Houdry Corp. Hudson—Hudson Engineering Corp. H. W. P.—Head Wrightson Processes, Ltd. Hydro Res.—Hydrocarbon Research, Inc. Ind. Eng.—Industrial Engineers, Inc. J. & L. Constr.—Construction Division, Jones & Laughlin Supply Co. Kellogg—M. W. Kellogg Co. Koch—Koch Engineering Co. Koppers—Koppers Co., Inc. Leonard—Leonard Construction Co. Lummus—The Lummus Co. Mason—Mason Brothers Construction Co. McKee—Arthur G. McKee Co. Mid-Continent—Mid-Continent Engineering Co. Max Miller—Max B. Miller & Co. Parsons—The Ralph M. Parsons Co. Pet. Eng.—Petroleum Engineering, Inc. Petro—Petroleum Rectifying Co. Pritchard—J. F. Pritchard Co. Process Eng.—Process Engineers, Inc. Ref. Eng.—Refinery Engineering Co. Ref. Maint.—Refinery Maintenance Co., Inc. Rust Eng.—Rust Engineering Co. S. O. D.—Standard Oil Development Co. State Eng.—State Engineering Co. Stearns-Roger—Stearns-Roger Manufacturing Co. Stone & Webster—Stone & Webster Construction Co. Tellepsen—Tellepsen Construction Co. Texaco—Texaco Development Co. U. O. P.—Universal Oil Products Co. Walco—Walco Engineering. Wohlfeld—Wohlfeld Construction Co. Equally owned by California Texas Corp. and Socony-Vacuum Oil Co., Inc.



Accurately made to close tolerances
Uniform rib width
Ample lap widths
No cracks on outside corners
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No Wrinkles... No Cracks... No Blowouts!

no place for leaks in THIS heat exchanger gasket

TAKE A CLOSE LOOK at the Goetze heat exchanger gasket shown above. Note the absence of cracks on outside corners . . . of wrinkles on inside corners . . . the uniform width of the ribs . . . the generous overlap of the metal jacket.

Attention to such important details is typical of the kind of care that goes into the forming of these custom-made gaskets. It is the secret of their dependable service—why you can count on them to stay on the job indefinitely without leaks or blowouts. And it's the reason they pay off in terms of less down-time and in the savings that result when gaskets *don't* have to be replaced at frequent intervals.

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Johns-Manville *Goetze* Gaskets

DAVISON *fluid synthetic cracking* CATALYSTS

Two important reasons why DA-1 is widely used by the refining industry to produce the equivalent of over 228,000 tank cars of gasoline annually are:

(1) a consistently high standard of uniformity. (2) *a record of satisfactory performance since the initiation of fluid catalytic cracking. DA-1 assures continuous operation at peak efficiency.*

To meet the varied requirements of refinery operators, DA-1 is available in three grades:

F-1, *fine grade* • **C-1,** *intermediate grade* • **C-2,** *coarse grade*

Our facilities also permit the production of special catalysts. We will cooperate with you in the development of the catalyst to meet your specifications. *Write for full information today.*

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Thermal Cracking of Fluid Catalytic Cycle Gas Oils

PETROLEUM REFINER
APRIL, 1949

H. McREYNOLDS and J. M. BARRON
The Texas Company, Port Arthur, Texas

THE present trend in refinery processing, for gasoline manufacture, is toward catalytic cracking and away from thermal cracking. This practice can be justified economically on the basis that catalytic cracking produces higher yields of gasoline and distillates at the expense of heavy fuel oil. If this trend continues, eventually catalytic cracking may replace thermal cracking. During this transition, feed stocks for the thermal operation are becoming less and less desirable from a yield-capacity standpoint because the more desirable virgin stocks are being diverted to the catalytic cracking units. Currently, many refiners are filling at least some portion of the charge requirements of the thermal units with fluid catalytic cycle gas oils.

Fluid catalytic cycle gas oils, although less degraded than thermal cycle gas oils, are nevertheless cracked distillates and have lower hydrogen-to-carbon ratios than the same gravity virgin stocks. Consequently, it would be expected that these cycle stocks would have different thermal cracking characteristics than virgin stocks. To what extent these differences affect yields and product quality, is of interest to the process engineer for plant balance reasons and for adjusting

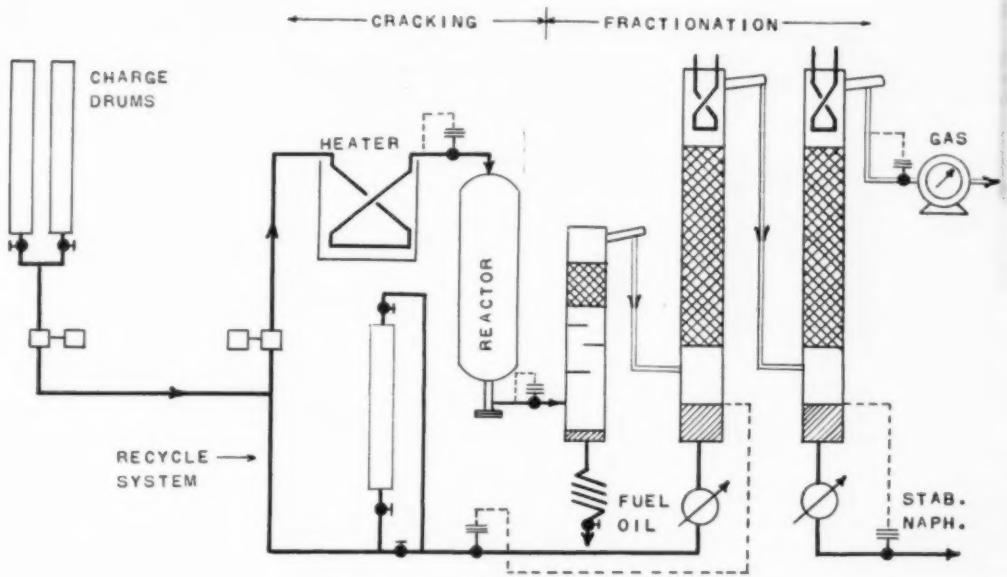


FIGURE 1
Thermal Cracking Unit

***A MAJOR PROBLEM** in catalytic cracking operations concerns the utilization of the cycle gas oils produced. Currently, many refiners having catalytic cracking equipment are routing these gas oils to existing thermal cracking units.*

In this article the authors report the results of extensive investigations into such operations. The thermal cracking properties of a large number of fluid catalytic cycle gas oils from various crude sources have been investigated. Correlations of yields, product quality, sulfur distribution, and fresh feed capacity have been developed. Spot comparisons were made with yields to be expected from virgin gas oils of the same API gravities. It is shown that fluid catalytic cycle gas oils tend to yield more cycle fuel oil and less naptha and dry gas than virgin gas oils. ASTM octanes are lower and the cycle fuel oils produced have a lower gravity for a given viscosity.

H. McReynolds is presently a member of the cracking research department of The Texas Company and has extensive experience with both laboratory and commercial scale cracking operations. J. M. Barron has devoted most of his professional efforts to cracking research, and has served some six years as director of this work at the Port Arthur plant of The Texas Company. He presently is a representative of Texaco Development Corporation for the Southwest.

specifications which might be affected.

It is the purpose of the authors to present correlations of yields, product quality, sulfur distribution and fresh feed capacity developed for thermal cracking of a large number of fluid catalytic cycle gas oils from various crude sources.

A total of 70 single recycle stream thermal cracking pilot unit runs were made as follows:

Runs for General Correlations	54
Runs for Effect of Naphtha 50 percent Point	6
Runs for Effect of Fuel Oil Gravity	10

Results from one plant scale thermal run charging a blend of typical commercial FCC cycle gasoils are also included.

Charge Stocks

Table 1 shows the pertinent tests and inspections of the 25 FCC (Fluid catalytic cracking) cycle gas oils investigated. These stocks were catalytically produced on both pilot plant and plant scale fluid catalyst cracking equipment, at catalytic conversions ranging from 42 to 88 percent. The wide range in character of the stocks investigated is indicated by the API gravities which varied from 18.1 to 42.5° API. In general, these stocks are low in sulfur.

Stocks 1 through 19 were produced by single pass fluid operations while stocks 20 through 24 were produced by partial recycling. Furthermore, it should be pointed out that stocks 20 and 23 are 100 percent decanted oils, i.e., material decanted from the Dorr settler of a Kellogg Fluid catalyst cracking unit, and are high in carbon residue. Special provisions were made to charge these stocks to the pilot cracking unit.

Apparatus and Procedure

A flow diagram of the pilot unit employed is shown in Figure 1. It will be observed that this unit consists of a coil and drum cracking system, which may be operated under pressure, and has a fractionation and stabilization system designed to operate at a lower pressure. Briefly, the flow through the system was as follows:

Fresh feed was pumped from a calibrated charge drum to the suction side of the recycle pump. The recycle stream was pumped through four lead pot heaters in series. The reaction products were expanded from 650 to 400 psig. at the heater outlet by means of a pressure control valve, and further cracked in a down flow reactor. The effluent oil-vapor mixture passed through a pressure control valve where the pressure was reduced from 400 to 40 psig. At the reduced pressure, the oil stream entered a baffled flash tower where cycle fuel oil of the desired gravity was withdrawn from the system.

The materials leaving the flash tower

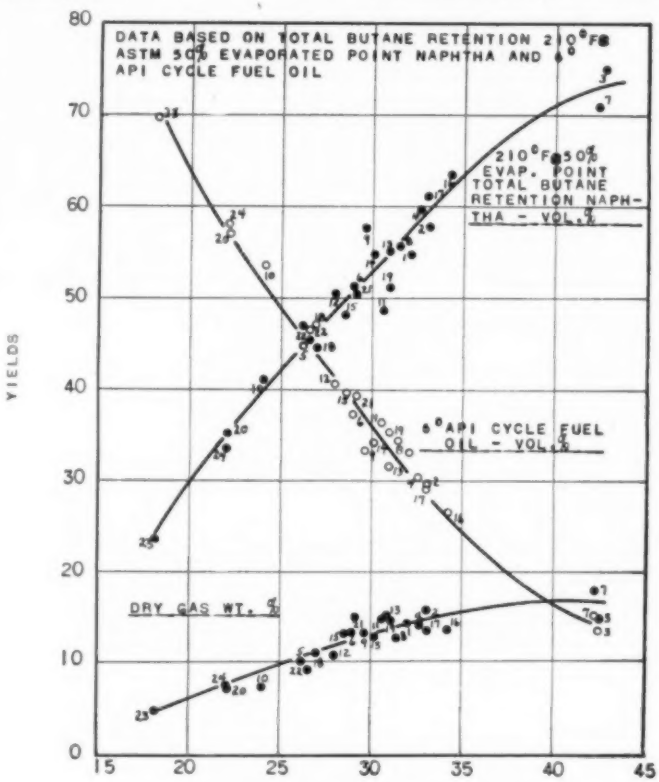


FIGURE 2
Yields vs. Charge Stock Gravity

top were directed to a fractionator where gas and 400° F. endpoint naphtha were taken overhead to a continuous stabilizer while the fractionator bottoms were recycled through the cracking zone.

The gas-naphtha fraction was stabilized and a propane free naphtha of the desired Reid vapor pressure was removed from the system as stabilizer bottoms. The gas taken overhead from the stabilizer was expanded from 40 to 5 psig. where the gas was sampled, then further expanded to atmospheric pressure and measured by means of a wet test gas meter.

The decanted oils (Stocks No. 20 and 23) and those charge stocks high in carbon residue, because they contained decanted oil, were flashed in the low pressure flash tower before being recycled to the cracking zone, thus removing the high carbon residue constituents with the cycle fuel oil.

Because charge stock quantity was limited in many instances, no deliberate attempt was made to establish the most severe operating conditions allowable on each of the stocks evaluated. However, in general, when a new stock was to be evaluated the severity of operating conditions was set as high as possible, based on past experience when considering charge stock gravity, characterization factor, and carbon residue. If sufficient stock was available, additional runs were made at higher conversion levels.

Because fluid catalytic cycle gas oils tend to produce a lower viscosity cycle fuel oil for a given cycle fuel oil gravity than do virgin stocks, cycle fuel oil gravity was maintained as low as was consistent with good operations.

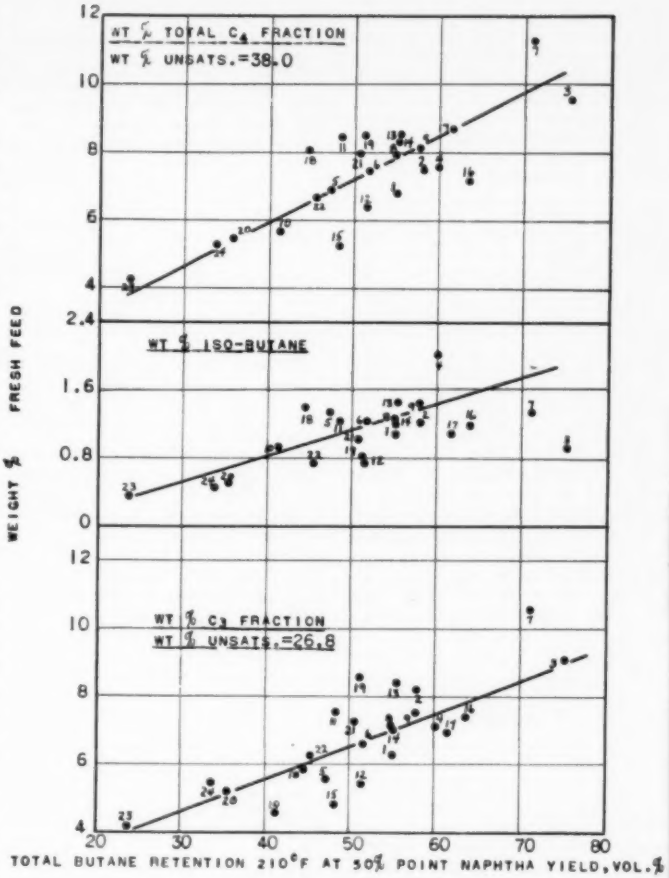

WT % TOTAL C4 FRACTION
WT % UNSATS.=38.0
WT % ISO-BUTANE
WT % C3 FRACTION
WT % UNSATS.=26.8
WEIGHT % FRESH FEED
TOTAL BUTANE RETENTION 210°F AT 50% POINT NAPHTHA YIELD, VOL.%

FIGURE 3
Variation of C_3 and C_4 Hydrocarbon Yields with Total Butane Retention Naphtha Yield

TABLE 1—Charge Stocks

Point No.	IDENTIFICATION	No. Runs Made	Catalytic Conversion At Which Stocks Were Produced	Gravity of Catalytic Cycle Gas Oil °API	Sulfur Bomb-Weight Percent
1	Total Cat. Cycle From Asphalt Base Gas Oil	1	42	33.0	0.12
2	Total Cat. Cycle From Wide Range Paraffin Base Gas Oil	1	43	33.0	0.11
3	Total Cat. Cycle From Paraffin Base Gas Oil	3	43	42.5	0.05
4	Total Cat. Cycle From Heavy Paraffin Base Gas Oil	2	47	32.6	0.13
5	Total Cat. Cycle and Decanted Oil From Mixed Base Gas Oil*	3	48	26.1	0.44
6	Total Cat. Cycle From Asphalt Base Pressure Distillate	1	50	28.9	0.46
7	Total Cat. Cycle From Paraffin Base Gas Oil	2	52	42.3	0.05
8	Total Cat. Cycle From Mixed Base Gas Oil	3	55	31.4	0.18
9	Total Cat. Cycle From Mixed Base Gas Oil	1	55	29.5	0.27
10	Heavy Cat. Cycle From Paraffin Base Gas Oil	2	56	34.0	0.39
11	Light Cat. Cycle From Mixed Base Gas Oil	1	60	30.5	0.31
12	Total Cat. Cycle From Mixed Base Gas Oil	1	60	27.9	0.26
13	Total Cat. Cycle From Mixed Base Gas Oil	2	60	30.9	0.34
14	Total Cat. Cycle From Asphalt Base Gas Oil	6	60	30.1	0.44
15	Total Cat. Cycle From Mixed Base Gas Oil (Plant Scale Run)	1	60	28.5	0.05
16	Heavy Cat. Cycle From Light Paraffin Base Gas Oil	3	62	34.2	0.13
17	Light Cat. Cycle From Light Paraffin Base Gas Oil	3	62	33.0	0.10
18	Total Cat. Cycle From Asphalt Base Pressure Distillate	1	64	26.9	0.63
19	Heavy Cat. Cycle From Paraffin Base Gas Oil	6	70	30.9	0.24
20	100 Percent Decanted Oil From Paraffin Base Gas Oil	3	70	22.1	0.53
21	Blend Heavy Cycle & Decanted Oil From Paraffin Base Gas Oil*	1	70	29.0	0.33
22	Heavy Cat. Cycle From Paraffin Base Gas Oil	3	86	26.5	0.34
23	100 Percent Decanted Oil From Paraffin Base Gas Oil	2	88	18.1	0.42
24	Blend Heavy Cycle & Decanted Oil From Paraffin Base Gas Oil	2	88	22.0	0.44
25	Mixed Base Virgin Gas Oil	1	.....	31.5	0.33
26	Total Cat. Cycle From Mixed Base Gas Oil (Effect of CFO Grav. & Naph. Volatility Study)	16	48	27.1	0.82

* Blended in Ratio of Production.

Yields

Figure 2 shows the variation of the yields of naphtha, cycle fuel oil, and gas with charge stock gravity. These data are based on the production of total butane retention 210° F. ASTM 50 percent evaporated point naphtha and 6° API cycle fuel oil. (Point numbers refer to charge stocks—see Table 1).

It will be noted that the data correlate on a single line and very little, if any, effect of catalytic conversion is apparent from these data, e.g., yields from Stocks 1 and 2 produced at 42 percent catalytic conversion fall on the curve equally as well as yields from Stocks 23 and 24 which were produced at 88 percent conversion. Charge stock characterization factor[1] was considered in correlating these data, along with gravity, but the relationship developed was not as good as when based on gravity alone.

The cycle gasoils produce less naphtha and more fuel oil than virgin gasoils of the same gravity. This is illustrated in the following tabulation which shows the difference in yield from cracking virgin and catalytic cycle gas oils at three gravity levels. In this tabulation (—) indicates lower and (+) indicates higher than virgin yields.

Charge Stock Gravity, °API	20	30	40
Naphtha, Vol. Percent	— 9.9	— 3.8	— 2.2
Cycle Fuel Oil, Vol. Percent	+10.3	+2.8	+1.5
Gas, Weight Percent	— 4.5	0.0	+1.3

Octanes from thermal cracking FCC cycle gas oils are generally lower than those obtained from cracking virgin gas oils. This is particularly true when cracking low characterization factor feed stocks. As the stock becomes more paraffinic, the octane more nearly approaches that produced from virgin stocks. More specifically, the ASTM octane of the total butane retention naphtha, from FCC cycle gas oils having characterization factors lower than 11.5 is approximately 2 numbers lower than from virgin gas oils. This difference decreases to about 1 octane number when processing stocks having characterization factors greater than 11.5.

Light Hydrocarbon Production

Figures 3 and 4 show the variation of propane, butanes, isobutane, pentanes, normal pentane and isopentane with yield of total butane retention 210° F. 50 percent point naphtha. Also shown, are the weight percent unsaturates of the total propane, butane and pentane fractions, basis the fraction. It will be noted that, as the total butane retention naphtha yield increases, the yield of light hydrocarbons increases; however, the percent unsaturates was found to be essentially constant over the range investigated.

Prediction of Fresh Feed Capacity

Figure 5 is a correlation of the fresh feed capacity, expressed as percentage of the total heater throughput, against a factor expressing charge quality and depth of cracking. The mathematical relationship of these variables is expressed by the following equation:

$$Z = -15.9980 + 2.3604\,C - 0.03819\,C^2 + 38.431\,R$$

Where:

Z = Fresh Feed, Percent of Heater Feed.

C = Crack Per Pass = $\dfrac{\text{Bbls./Hr. Total Butane Retention Naphtha}}{\text{Bbls./Hr. Heater Throughput}} \times 100$

$R = \dfrac{K_b}{\Delta\ \text{API}}$

$K_b = \dfrac{(\text{Charge Stock Molal Avg. Boiling Point °Rankine})^{1.3}}{\text{Charge Stock Specific Gravity}}$

$\Delta\ \text{API}$ = Charge Gravity °API — Cycle Fuel Oil Gravity °API

The applicability of the data to the correlation is indicated by a standard deviation of ±2.0 and an average deviation of ±1.6.

Specific use of Figure 5 is limited to the laboratory unit on which work was done, and to plant units having the same coil-drum ratio; however, the magnitude of the effect of the various variables should be approximately the same on similar equipment when charging FCC cycle gas oils.

Effect of Naphtha 50 Percent Point on Yields

A study was made to determine the effect of naphtha 50 percent point on yields, in order to permit adjustment of the data obtained to a constant mid-range volatility. A single fluid catalytic cycle gas oil charge stock was selected for this study (Stock 24, Table 1). Six runs were made varying naphtha endpoint by under-cutting. While the severity of cracking and the cycle fuel oil gravity remained constant, the range of variation of naphtha endpoint was from 369 to 473° F. and resulted in a variation in ASTM evaporated 50 percent point from 171 to 224° F., basis total butane retention naphtha.

Figure 6 presents a graphical summation of the results obtained. This figure shows the relation between the ratio of the total butane retention naphtha yield at an ASTM 50 percent evaporated point of 210° F. to total butane retention naphtha yield at an observed ASTM 50 percent evaporated point, and the observed ASTM 50 percent evaporated point. The corresponding change in 6° API cycle fuel oil and dry gas for a given change in naphtha yield when adjusting to 210° F. evaporated 50 percent point is shown to be 57 Vol. percent to cycle fuel oil and 51 Wt. percent to dry gas.

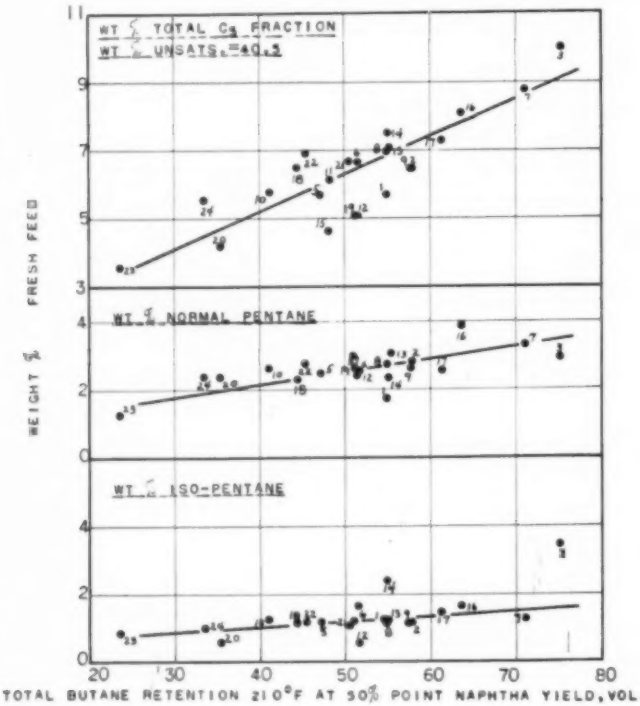

WT % TOTAL C3 FRACTION
WT % UNSATS. = 40.3
WT % NORMAL PENTANE
WT % ISO-PENTANE
WEIGHT % FRESH FEED
TOTAL BUTANE RETENTION 210°F AT 50% POINT NAPHTHA YIELD, VOL.%

FIGURE 4
Variation of C$_5$ Hydrocarbon Yields with Total Butane Retention Naphtha Yield

Effect of Cycle Fuel Oil Gravity on Yields

A study was made to determine the effect of cycle fuel oil gravity on yields; this was deemed necessary for establishing a basis for adjusting the data to a common basis for comparative purposes. The same charge stock (Stock 24, Table 1) which was used for studying the effect of naphtha 50 percent point was used in this work. Runs were made while varying heater outlet temperature to give essentially the same crack per pass. Cycle fuel oil gravity varied from about —1 to 10° API.

Figure 7 presents a graphical summary of the results obtained. For convenience in adjusting yields to a 6° API cycle fuel oil gravity basis, the ordinate is expressed as a ratio of yields at 6° API cycle fuel oil gravity to yields at observed fuel oil gravity, while the abscissa is expressed as the observed cycle fuel oil gravity.

Viscosity-Gravity Relationship of Cycle Fuel Oils

Figure 8 is a viscosity-gravity chart[1] used to show the vis-breaking characteristics of a thermal cracking operation. Curve No. 1 on this chart is an average of the data obtained on FCC cycle gas oils whose parent stocks were mixed base virgin gas oils (Stocks Nos. 5, 9, 12, and 13, Table 1). Curve No. 2 is based on data on virgin mixed base gas oil (Stock No. 25). Curve No. 1 indicates FCC cycle gas oils produced at 50 percent catalytic conversion will yield a 100 viscosity @ 122 F. Furol cycle fuel oil of approximately —5° API gravity as compared to 2.5° API for the virgin stock. Furthermore, the curves shown appear to be almost parallel. This implies that the amount of vis-breaking in the thermal operation is not materially different for virgin or FCC cycle gas oils. In other words, the differences are approximately the same as the differences noted in the charge stocks, and, therefore, the lower fuel oil gravities required for a given viscosity range, when cracking catalytic cycle gas oils thermally, are due primarily to the vis-breaking obtained on the virgin stock in the catalytic cracking operation.

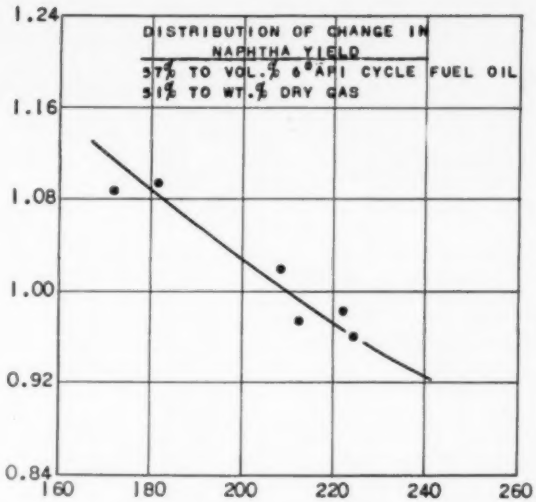


FIGURE 6

Variation of Total Butane Retention Naphtha Yield with Change in ASTM 50 Percent Evaporation Point

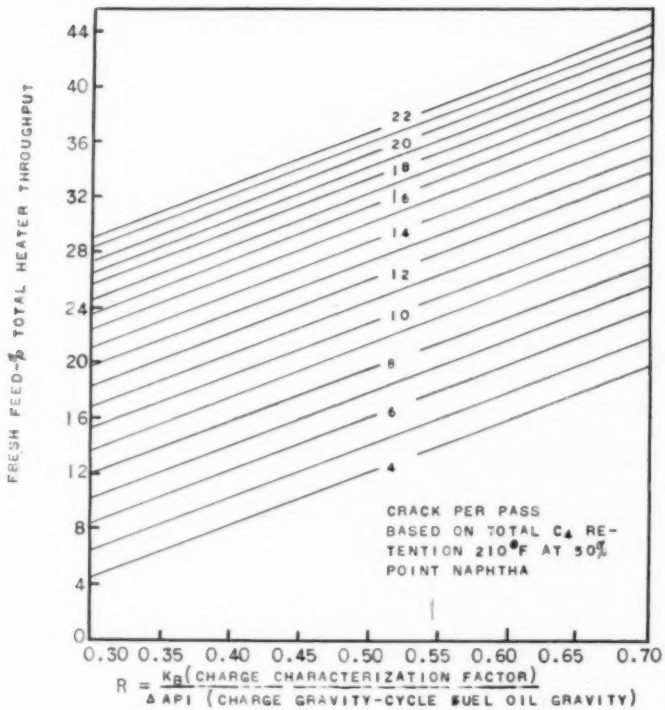


FIGURE 5

Variation of Fresh Feed Capacity with Conversion per Pass and Charge and Cycle Fuel Oil Quality

Sulfur Distribution

The average sulfur recovery, basis sulfur in the fresh feed, for the runs made, is 94.3 weight percent. Sulfur is indicated to be distributed in the products approximately as shown in the table which follows.

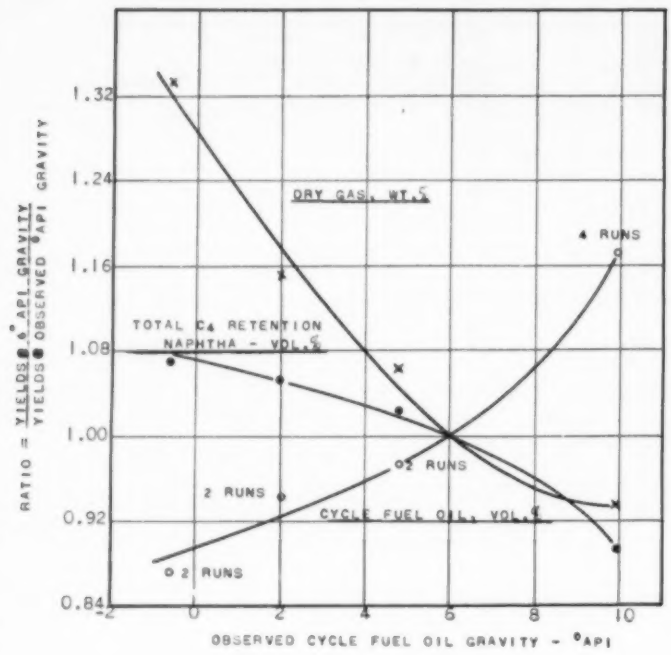


FIGURE 7

Variation of Yields with Change in Cycle Fuel Oil Gravity

	Average	Range*
1. Naphtha, Weight Percent	5.2	1.5 to 7.0
2. Cycle Fuel Oil, Weight Percent	88.8	85.0 to 98.5
3. Gas, Weight Percent	6.0	3.0 to 9.0

* Exclusive of Charge Stock 3 and 7, Table 1, which are very low in total sulfur and sulfur distribution is considered unreliable.

These results were based on bomb sulfur analyses[2] on the charge and cycle fuel oils, and lamp sulfur analyses[3] on the naphtha. Tutwieler H_2S determinations[4] were made on the product gas.

Conclusions

FCC cycle gas oils are poorer thermal cracking stocks than virgin gas oils since they tend to yield more cycle fuel oil and less naphtha than the corresponding virgin gas oils of the same gravity. These yield differences are greater for charge stocks having low API gravities. In general, the ASTM octanes are lower than those from the same gravity virgin gas oils. The cycle fuel oil produced from FCC cycle gas oils are lower in API gravity than the corresponding cycle fuel oils from virgin gas oils, basis 100 Saybolt Furol viscosity @ 122° F., due to the visbreaking obtained in the FCC operation.

BIBLIOGRAPHY

[1] Watson, Nelson, and Murphy Ind. & Chem. 27, 1460 (1935).
[2] ASTM Method D 129-44.
[3] ASTM Method D 90-47T.
[4] Gas Chemists Handbook A.G.I., 1916, pages 160-163.

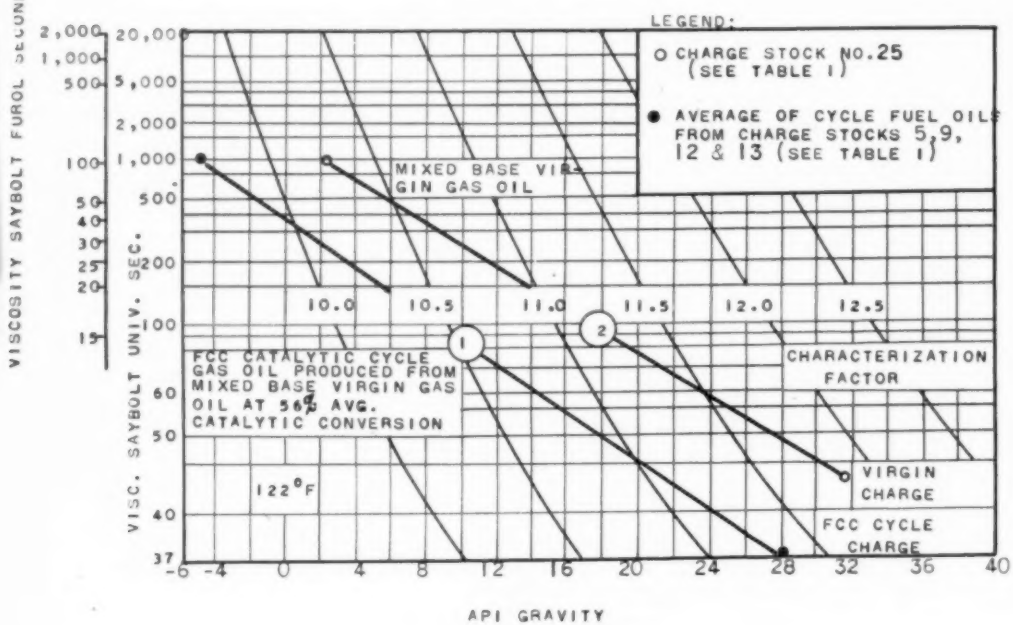


FIGURE 8

Viscosity Gravity Relationship of Cycle Fuel Oils

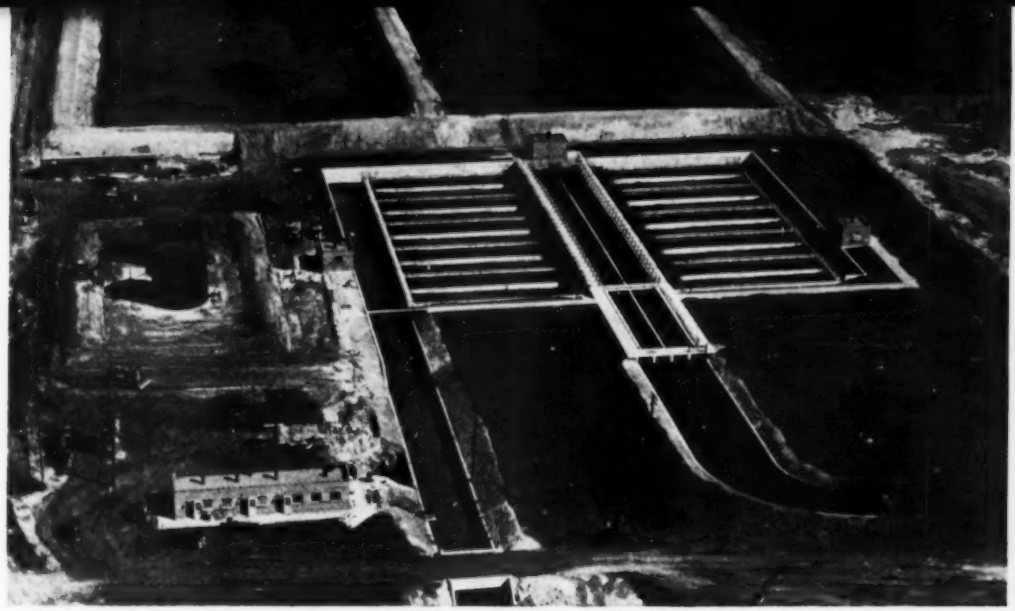


Figure 2—Aerial View of Oil-Separator Facilities, Toledo Refinery.

Oil Separator for Waste Water Disposal

G. E. KING
Technical Service Division,
Standard Oil Company (Ohio), Cleveland

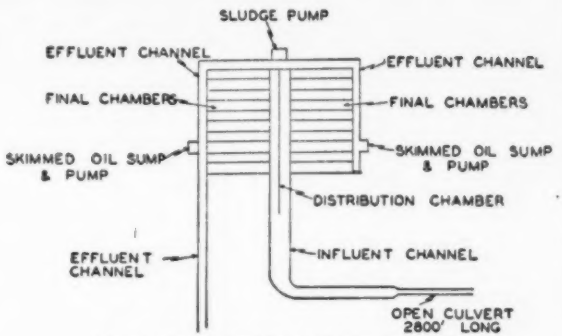


Figure 1—General Plot Plan of Oil Separator Proper.

***BOTH RECENT** legislative interest in waste disposal and the long-term programs for operations improvement which are conducted by refiners generally have stimulated a high degree of interest in apparatus for handling plant waste-water. In this article, presented to a Group Session on the Disposal of Refinery Wastes during the 14th Mid-Year Meeting of the American Petroleum Institute's Division of Refining, in Houston the author recounts the development and operating results obtained with a separator intended for 35,000 gallons per minute of waste-water plus 10,000 gallons per minute rainfall runoff. The new separator has improved the quality of the refinery effluent, and has prevented the loss of oil.*

DUE to the increased refining capacities and resulting increase in waste water discharged, a new oil separator has been constructed to process these waste waters from the refineries of The Pure Oil Company and The Standard Oil Company (Ohio) located at Toledo. The improved facilities were placed in operation in August 1947. During the preceding years the refineries had been served by a separator installed in 1920. To provide a satisfactory treatment for a large volume of water, the new oil separator gives adequate retention time and it incorporates many novel design features.

The plot plan of the oil separator proper at Toledo is shown in Figure 1. An aerial view of the installation, taken shortly after it had been placed on operation, is presented in Figure 2. The oil separator is located about ½ mile from the major refining units. The water flows from the refineries to the separator in an open culvert, shown at the lower right of Figure 2. The water enters the separator through the influent channel, and flows through the distribution chamber into the intermediate and final chambers and the effluent channel into Otter Creek. Skimmed-oil sumps and pumps are located at both ends of the final chambers. The sludge pump is located at the end of the distribution chamber. Two sludge ponds and two skimmed oil-

storage tanks are provided for settling purposes. In the main pump house, at the lower left, are the fire water pumps the recovered oil-transfer pump, and the separator office.

The effluent waters from the separator flow about ⅛ mile to Otter Creek—entering the stream one mile from Maumee Bay of Lake Erie. Because of the location of the stream, the facilities installed were of interest to agencies of the local, state, and national governments. In Ohio, the Board of Health coordinates the waste-disposal activities of industries and municipalities. This board reviews and approves all installations that are being constructed for the purpose of controlling the quality of waste water from industrial sources. This oil-separator installation was approved by the Ohio State Board of Health. The oil separator represents a step forward in the control of the quality of refinery effluent waters.

Design of Separator

In working out the design of the oil separator, an installation was developed to meet the local situation. Factors other than the physical characteristics of the waste water were involved. The area available for the separator was located a considerable distance from the main sources of the waste water. The terrain is level, and lies but a few feet above the normal level of Lake Erie. The highest point in the refinery collection system is about 4 feet above normal lake level and only 1 foot above the maximum level. To meet this factor, the separator must operate with minimum loss of hydraulic head to prevent backing up into the collection system.

The separator serves two refineries with a combined crude oil capacity of about 55,000 barrels per day. Due to the fact that one refinery uses once-through cooling water on all process units, thus accounting for about 85 percent of the normal flow to the separator, an extremely large volume of water was to be processed. Closed cooling-tower circuits are used in the other refinery, thereby reducing the effluent waters. In addition to the normal process-water flow, the rainfall runoff from about 360 acres of property is drained to the separator by a common collection system. An annual rainfall of about 30 inches is normal for the Toledo area.

In developing the design of this waste-water separator, the following factors played an important part: 1) minimum total installed cost; 2) maintenance and operating costs; 3) minimum head loss in the system. In the design of a separator, these factors were given the maximum weight that would give a satisfactory effluent.

TABLE 1
Calculated Volumes of Rainfall Runoff: Oil Separator—Toledo Refinery

Volume (Gallons Per Minute)	Time (Hours Per Year)	Time (Percent)
0- 2,500	915	88.9
2,500-10,000	89	8.6
10,000-25,000	19	1.8
25,000-45,000	7	0.7
	1,030	100.0

TABLE 2
Characteristics of Waste-Water: Oil Separator—Toledo Refinery

	Low Average	High Average
Temperature of water, °F.	70	105
Turbidity of water, ppm	125	400
Gravity of separated oil, °API	23.0	36.0

Physical Characteristics of Waste Water

The data on the waste water to be processed in the oil separator were collected in a series of plant studies with results supplying information on the following items: 1) volume of process water; 2) volume of rainfall runoff; 3) temperature of the water; 4) turbidity of the water; 5) gravity of the separated oil. The major portion of a year was required to obtain data on the maximum and minimum conditions which existed in the waste-water system.

The maximum flow of process water from both refineries was found to be 35,000 gpm. Two methods were used in arriving at this figure. The volume of water delivered to the refineries from the water-pumping station was corrected for known losses, i.e., steam production, evaporation and windage losses, and seepage. This figure was verified by flow measurements in the open culvert which delivered the water to the old separator site. To determine the volume of rainfall runoff from both refineries, local data on rainfall, as well as the runoff coefficients developed for that area, were used. In Table 1 the results of the rainfall-runoff calculations are presented. A study of these data shows that the total volume of rainfall runoff is below 10,000 gpm. during the major portion of the time. During only 26 hours each year the rainfall runoff would be expected to exceed 10,000 gpm. Rainfall runoff in excess of 25,000 gpm. represents an abnormal condition which occurs only 7 hours per year. To handle rainfall runoff in excess of 10,000 gpm., two schemes were considered. Additional chambers could be constructed, or storage tanks could be erected for impounding the runoff water.

The data on the characteristics of the waste water are shown in Table 2. Low average and high average figures are given for turbidity and temperature of the raw waste water, and for the gravity of the separated oil. For the initial design, the low average value was used in the case of the temperature of the waste water (70° F.) and the gravity of the separated oil (23.0° API). The high average value of the turbidity (400 parts per million) was used.

Development of Design

In general, the design of the oil separator was based on the criteria established in the API publication, *Disposal of Refinery Wastes—Section I: Waste Water Containing Oil* (1941). The oil-separator facilities of many other refineries were inspected for the gaining of background for a new design. The operation of the oil separator of complete API design at the Cleveland refinery of Ohio Standard was followed closely.

After all the factors in the design of the separator had been considered, it was believed advisable to install a unitary chamber-type separator. This differs from the conventional API design in that the API separator has a primary chamber equivalent to the basic chamber in length, developed from design calculations, and a secondary chamber which is 1.4 times the basic chamber in length. In developing the layout for the unitary chamber, it was also found, from the standpoint of head loss and initial cost of installation, that an influent channel and distribution chamber like that shown in the plot plan would be most attractive. The influent channel and distribution chamber serve as a primary chamber in the separation of the oil and sludge from the waste water. In effect, a two-chamber system was designed. Using the method outlined in the aforementioned API publication, the size of the basic chamber was determined.

Inasmuch as more than one separator section was to be required, the original calculation was based on the maximum process water flow of 35,000 gpm. The physical factors used in the calculations were obtained from the values determined in the plant surveys, a temperature of 70° F., a turbidity of 400 ppm, and a gravity of the separated oil of 23.0° API. The initial calculations showed that 15 basic chambers of the maximum size were required for the maximum process waste-water flow. As shown in Table 3, the final design was adjusted to 16 chambers, each having a width of 18 feet. The depth of the basic chamber was

7.75 feet and the length 50.7 feet. The chambers in the Toledo installation are 86 feet long. A unitary chamber would have an overall length of 122 feet. The difference in length of 36 feet between the API unitary chamber of 122 feet and the installed chamber of 86 feet was obtained, in effect, by the influent channel and distribution chamber. Subsequent operation justified this system, because it successfully processed the waste waters.

As indicated previously, it was decided to make provisions for handling 10,000 gpm. of runoff water. Four additional chambers were required for this purpose. To handle the runoff in excess of 10,000 gpm., two methods are available, and are currently being investigated. The plot plan was developed so that eight additional chambers can be installed to handle additional runoff water. Impounding of runoff water in excess of 10,000 gpm. is also being considered, and appears to be promising. The impounding of excess runoff water over 10,000 gpm. should allow some separation of oil and solids, and should make subsequent treatment somewhat easier. The economics of such a system will also be a primary factor in determining the better method.

TABLE 3

Size of Basic Chamber Vs. Size of Installed Chamber (1941 API Method): Oil Separator—Toledo Refinery

(Basis: Process water = 35,000 gpm.)

	Basic	Unitary	Installed
Number of chambers	15	15	16
Width, feet	19.4	19.4	18
Depth, feet	7.75	7.75	7.75
Length, feet	50.7	122.0	86

TABLE 4

Summary of Design Conditions: Oil Separator—Toledo Refinery

Process Water (gpm.)	Rainfall Runoff (gpm.)	Tota (gpm.)	Velocity (Feet Per Minute)	Notes
35,000		35,000	1.65	
35,000	10,000	45,000	2.12	API

TABLE 5

Observed Data on Operation: Oil Separator—Toledo Refinery

Process water (maximum), gpm	26,500
Temperature of water (minimum), °F.	70
Gravity of separated oil, °API	27.0
Turbidity of water, ppm	200

TABLE 6

Summary of Actual Conditions: Oil Separator—Toledo Refinery

Process Water (gpm.)	Rainfall Runoff (gpm.)	Total (gpm.)	Velocity (Feet Per Minute)	Notes
26,500		26,500	1.25	
26,500	10,000	36,500	1.75	
26,500	20,000	46,500	2.22	API

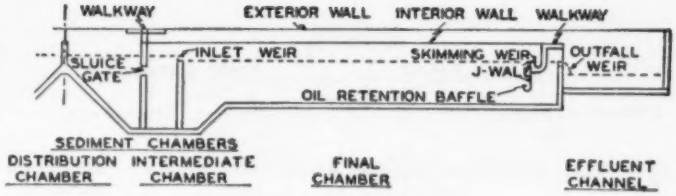


Figure 3—Sectional View of Oil Separator.

In summarizing the relationship between the final chambers in the design of the Toledo separator and the requirements of the API design, the conditions that exist in the separator at various flow rates are given in Table 4. At maximum process waste-water flow, the separator is oversized. The velocity in the final chambers is 1.65 feet per minute. The capacity for a separator of 20 sections, according to the API method of design, is 45,000 gpm. At this rate the velocity is 2.12 feet per minute.

In following the operation of the oil separator, additional data were collected on the volume of water being processed and on the physical characteristics of the waste water. The maximum flow of waste water was determined as 26,500 gpm. (see Table 5). The low average temperature was 70° F., and the gravity of the oil on a low-average basis was 27.0° API. The turbidity of the water in the influent channel was 200 ppm.

Using the data on the volume, including 10,000 gpm. of runoff water, as well as the physical characteristics of the waste water, the actual capacities of the separator under current operating conditions were calculated. The same method as used in the original design was used in the recalculation. At these rates and conditions the present separator installation is about 25 percent in excess of those required by the recommended API design.

To summarize the conditions that exist in the Toledo separator, the calculated velocities are shown in Table 6. At the maximum process waste-water flow, the velocity is 1.25 feet per minute. The velocity is 1.75 feet per minute when 10,000 gpm. of rainfall runoff is added to the waste-water flow. When 20,000 gpm. of rainfall runoff is added to the maximum process waste water, the velocity is 2.22 feet per minute.

Special Design Features

As previously indicated, this installation does not strictly follow the API method of installing primary and secondary chambers. In developing the plot plan the most logical layout, from the standpoint of head loss and economics, resulted in a two-chamber system for this installation. The field information indicated that the primary separation of oil and solids from water occurs at velocities higher than those recommended in the API chamber. A major portion of the oil was separating in the open culvert where the water is flowing at a high velocity. To complete the primary separation and to deliver the water to the final chambers, a distribution chamber replaced the influent channel and primary sections of the conventional API design. The distribution chamber was located centrally to take advantage of common walls. Primary distribution was accomplished by a dividing wall throughout the length of the chamber. Oil- and sludge-removal facilities were provided for handling separated oil and sediment. The average velocity of the waste water in the distribution chamber is 11.0 feet per minute at the maximum process flow of 26,500 gpm. In the open culvert, in the influent channel, and in the distribution chamber the waste water receives treatment almost equivalent to that received in a primary section of the required length.

Except for the length, the final chambers were sized in the manner described in the API publication of 1941. A sketch of the cross-section of the final chamber is shown in Figure 3. In this inlet-end design, the head loss is minimized, and is 75 percent less than the head loss through the API front-end design. The water flows from the distribution chamber through submerged sluice gates into an intermediate box. The water flows over a full-width weir into the final chamber. The flow of the water is not reversed at any point, and enters the final chamber at the normal operating level. The outlet-end design follows the conventional procedure. A steel oil-retention baffle of the proper curvature extends downward from a concrete wall. The concrete J-wall is of the design required by the oil-removal equipment. The skimming weir works in conjunction with skimming blade.

For the removal of separated oil and sediment, overhead-skimmer scraper units were installed, as shown in

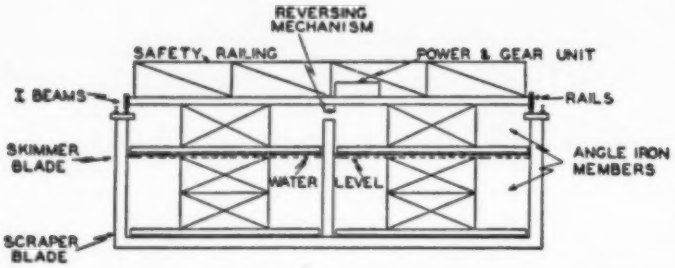


Figure 4—Overhead Skimmer: Scraper Unit of Oil Separator (Scraper Blade in Position).

Figure 4. These units operate on rails atop the interior walls of the final chambers. All moving parts are located above the surface of the water. On the upstream run, the unit scrapes settled solids into the sediment chambers at the inlet end. On the downstream run, the skimmer blade is immersed—moving the separated oil to the outlet end of the chamber. The oil removal is a positive accomplishment, for the skimmer blade makes contact with the skimming weir and pushes the oil into the trough formed by the J-wall. A minimum amount of water is removed in the operation. The overhead skimmer, the skimming weir, and the oil trough differ from the flight skimmers and oil-collecting pipes suggested in the API design. The effectiveness of either type of unit is dependent on the conditions that exist in the separator. The capacity of the flight skimmer for removing separated material may be greater, but the overhead units normally are easier to maintain. If not overloaded, the overhead skimmer gives positive oil removal, and removes a relatively small amount of water. The oil-collecting pipes usually require continual adjustment as the quantity of waste water varies.

Description of Separator

The general layout of the separator facilities is shown in Figures 1 and 2. The area required for the entire installation is about 10 acres. The oil separator is constructed of reinforced-concrete walls, and the pump houses are of brick construction. Earthen dikes are used for the sludge ponds. The entire area is finished with a surface coating of cinders. Because of the remote location of the separator facilities, safety and safe operation were considered in the design. A firewater system was installed, and connections were provided for portable foam equipment.

Flow of Water

In describing the oil separator in detail, the flow of the waste water through the unit will receive initial consideration (see Figure 5). The distribution of the water is controlled at two points, viz.: at the inlet to the distribution chamber, and at the inlet to the final chambers. The flow of the water to either half of the distribution chamber is stopped by the use of gates at the inlet end. Steel flood gates can be fitted into slots in the concrete walls. The distribution of water to each of the final chambers is controlled by sluice gates. Three submerged sluice gates are provided at the inlet end of each final chamber, and are operated from the walkway over the dividing wall. The submerged type was used to prevent the entry of separated oil into the final chamber. The level of water in the separator is maintained by steel weir plates. The weir plates can be leveled and adjusted to the desired height. The final chamber inlet weir is set to maintain the normal operating level in the distribution chamber. The outfall weir maintains the proper level in the final chambers. The level in the distribution chamber can be raised, through a small range, by the closing of a number of the sluice gates.

In operation, the oil separator is used in its entirety at all times. The flow of water to either half may be cut off at any time for inspection, cleaning, or repairs. The flood gates mentioned previously herein are used in this instance. Using the 20 final chambers at the present flow of process waste water, even distribution is made between either half of the separator. At the maximum process flow, the velocity of the water is gradually reduced from point to point in the separator, as shown in Table 7. To keep the separated oil moving in the distribution chamber during the operating day, the flow of water into the final chamber at the end of either side is about 25 percent greater. The water flowing into these sections has received the longest treatment in the distribution chamber. At a flow rate of 46,500 gpm., the residence time for each individual chamber is about 37 minutes (Table 8). Equivalent treatment to the total separator effluent is obtained in this manner.

Flow of Recovered Oil

The initial separation of oil occurs in the open culvert (2800 feet in length) and in the influent channel (180 feet in length). The velocity of the waste water is sufficient to carry the surface oil into the distribution chamber, where equipment for recovery is located (see Figure 6). One of eleven overhead skimmer units is located in the distribution chamber. The remaining ten units operate in the final chambers, each serving two chambers. The skimmer in the distribution chamber operates at 6 feet per minute; those in the final chambers, at 2 feet per minute. The blade is equipped with neoprene wipers. At the downstream end of each chamber are located the skimming weir and the oil trough. The oil troughs slope toward a central point, where the oil drains into the sumps in the skimmed-oil pump house. The oil trough in the distribution chamber drains by pipe into the trough serving the final chambers. From the skimmed-oil sumps, the oil is pumped to the storage tanks by two vertical dry-pit pumps with a capacity of 150 gpm. at a head of 100 feet of liquid. The oil sumps have a capacity of 65 barrels. Two tanks, each having a capacity of 2100 barrels are located adjacent to the separator for skimmed-oil storage and settling. In the main pump house a 200-gpm. pump is provided for transferring the recovered oil to storage tanks in the refinery proper.

The overhead skimming units are

TABLE 7

Water Velocities: Oil Separator—Toledo Refinery

(Basis: Process water = 26,500 gpm.)

Point in System	Velocity (Feet Per Minute)
Open culvert	178.00
Influent channel	22.10
Distribution chamber	11.05*
Final chamber	1.25
Effluent channel	62.20

* Average.

TABLE 8

Residence Time: Oil Separator—Toledo Refinery

(Basis: Total flow = 46,500 gpm.)

Final Chamber No.	Flow (gpm.)	RESIDENCE TIME		
		Distribution Chamber	Final Chamber	Total
1 and 11	2250	0.05	37.25	37.30
2 and 12	2250	0.10	37.25	37.35
3 and 13	2250	0.15	37.25	37.40
4 and 14	2250	0.25	37.25	37.50
5 and 15	2250	0.40	37.25	37.65
6 and 16	2250	0.55	37.25	37.80
7 and 17	2250	0.85	37.25	38.10
8 and 18	2250	1.30	37.25	38.55
9 and 19	2450	2.40	34.15	36.55
10 and 20	2800	6.85	29.95	36.80

powered by electricity. In case of a stoppage, an automatic shutoff is actuated by the electrical overload. A master control panel is located adjacent to the separator. The units operate at a constant speed, and are reversed automatically at the end of the downstream run. Additional stops are installed, as necessary, for controlling the length of the run; or the units can be reversed manually. The transfer of skimmed oil from the sumps to the tanks is another automatic operation. A high-low level switch turns the pumps on and off. In case of an emergency, these pumps can be controlled manually.

The major portion of the separated oil is recovered in the distribution chamber. Two oil phases are present during normal operation, viz., free oil and heavy emulsion. The free oil is removed continuously during the day shift. The skimmer is operated throughout the shift on either full-length runs of 190 feet or on shorter runs of 30 feet or 60 feet, utilizing intermediate stops. If considerable free oil is present, the level is raised by closing sluice gates; and the oil flows freely over the skimming weir. By the same method the heavy emulsion is removed from the distribution chamber on a semi-weekly schedule. The skimmer is operated on manual control during the high-level operation. In the final chambers the volume of separated oil is considerably less. The units are operated through two complete cycles on the day shift. The 24-hour accumulation of oil and emulsion is removed by the downstream runs. The skimmed oil and emulsion flow by gravity to the oil sumps, where the float-controlled pumps transfer the material to the storage tanks. The tanks are used on alternate days, and provide 24-hour settling for the initial separation of water. The water from the storage tanks is drained into the influent channel. Daily transfers of settled oil are made.

Sludge-Handling System

Incorporated in the oil-separator design is an extensive system for the collection and handling of sediment (Figure 7). Primary separation of settleable solids occurs in the distribution chamber, and further separation results from the reduced velocity in the intermediate and final chambers. The settled solids are collected in 100 sediment chambers. In the distribution and final chambers the hoppers are shaped like inverted pyramids, with the sides sloping at a 45-degree angle. Forty chambers make up the floor of the distribution chamber. The 20 flat-bottomed intermediate chambers also serve as sediment chambers. In the final chambers two sediment chambers are located at the inlet end. The overhead skimmer units are equipped with a scraper blade for moving the sediment to the chambers. The scraper is lowered into position when the unit is reversed at the downstream end of the run.

A sludge header connects each of the sediment chambers to a pump located in the sludge pump house. A quick-opening-type valve is provided in a takeoff from the headers at each chamber. High-pressure flushing water is tied into the sludge headers at several points. The sludge pump has a capacity of 200 gpm. when it operates at a head of 50 feet of liquid, and it will handle large solids. The wet sludge is discharged into one of two settling ponds. The ponds are 125 feet by 380 feet, with a usable depth of 12 feet. Wet sludge can be discharged at either end of the ponds. Swing lines are provided for gravitating water and oil from the ponds to the separator influent channel.

The separation of sediment occurs continuously, and the resulting sludge is removed intermittently. In the distribution chamber no mechanical collection equipment is required. Settleable solids concentrate themselves in the bottom of the sediment chambers. In the final chambers the scraper blade moves the solids to the sediment chambers on the upstream run of the overhead unit. Two runs are made each day. The sludge pump is operated on alternate days, and the wet solids are transferred to the sludge-settling ponds. Each of the valves on the header is opened for about ½ minute. The sludge ponds are intended for alternate use. Thus far only one pond has been used. Sufficient settling is obtained between sludge removals so that clear water can be drawn off. With the exception of the operation of the overhead skimmer-scraper units, the

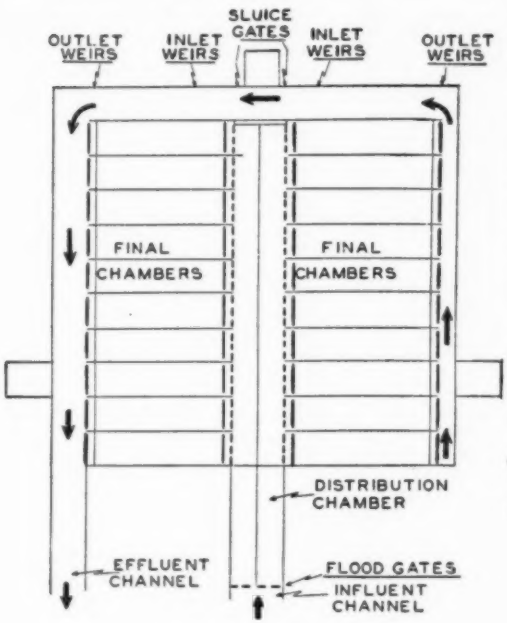


Figure 5—Control of Waste Water Flow.

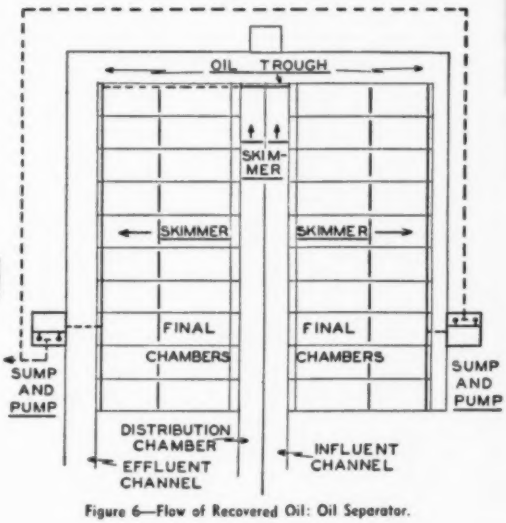


Figure 6—Flow of Recovered Oil: Oil Separator.

sludge-recovery system is operated and controlled manually.

Operation of the Oil Separator

The oil separator was placed in operation in 1947, and the procedures now in use were developed during the intervening period. The operation has not been free from process or mechanical difficulties. Some modifications have been made in the original equipment, and other equipment has been added to take care of unpredicated events. In general, the new oil separator has been satisfactory from both the standpoint of operation and that of effectiveness.

Variables of Operation

In developing the present operating procedure, variations were made in the method of operation. The overhead skimmer-scraper units initially were operated 24 hours per day. Inasmuch as only a small portion of the oil is separated in the final chambers, these units are operated through only two complete cycles at present. When the characteristics of the waste water change, and when more oil accumulates in the final chambers, the units are operated until the surface is oil-free. The units are stopped at the upstream end of the final chambers, with the skimming blade immersed to reduce surface turbulence created by the overflowing inlet weir. If the blade is not immersed, the effectiveness of the final chambers is reduced by about 10 percent. The movement of the submerged portion of the units through the water creates some turbulence. Preliminary tests have indicated that the effectiveness of the final chambers is reduced by about 25 percent when the units are in motion at the downstream end of the final chambers.

In the influent channel and in the distribution chamber, the major portion of the oil is separated. Initially the oil-removal facilities were overloaded. By increasing the speed of the skimmer to 6 feet per minute, by shortening the length of travel, or by raising the level of the water, the surface can be made relatively free from oil accumulations. The operation of the skimming unit has little or no effect on the separation in the distribution chamber.

In a similar manner the normal procedure for removing sediment from the separator was established. The sludge removal initially was accomplished twice daily, but was reduced to once on alternate days over a period of time. At one time the sediment was allowed to accumulate over a period of several days. Normal variations in the flow of the waste water caused sufficient agitation to stir up the sludge to an extent that tended to nullify the overall effectiveness of the oil separator. The major portion of the sediment settled in the distribution chamber and intermediate chambers, and only a small portion was present in the final chambers. The operation of the scraper through two upstream runs was established as being sufficient for normal operation.

TABLE 9
Analysis of Effluent-Channel Scum: Oil Separator—Toledo Refinery

MATERIAL	Percent by Weight
Solids, specific gravity > 1	20
Solids, specific gravity < 1	64
Water	12
Oil	4

The distribution of the waste water to the final chambers has been adjusted through a wide range. During the major portion of the time the distribution is equal. During the night, when no operators are on duty, the sluice gates are opened to take care of abnormal surges in flow. During the day, when the oil-removal system is in operation, the flow is adjusted to carry the separated oil into the distribution chamber as far as possible. As yet no portion of the separator has been shut down for cleaning.

In the operation of the oil separator the primary difficulties have been experienced as the result of the pre-separation of oil and sediment in the influent channel. Some of the measures taken to overcome these problems have been described in the foregoing sections. Another aid to the removal of free oil was the installation of an auxiliary pipe skimmer at the inlet end of the distribution chamber. The pipe skimmer was fitted into the slots provided for the flood gates, and was connected to the oil trough of the final chambers. A steel boom was suspended across the influent at the water level to direct the free oil into the skimmer. The velocity of the water in the influent channel was sufficient to carry the free oil to the skimmer. Some presepanation of sediment occurs in the influence channel. No attempt has been made to remove the accumulation. A state of equilibrium for normal rates of flow was reached. During periods of high flow a portion of the sediment is swept into the distribution chamber, placing an additional load on the oil separator.

Immediately after the oil separator had been placed in operation, a light scum appeared on the surface of the effluent channel. The scum contained only a very small amount of oil (Table 9), but gave an unsightly appearance to the effluent waters. In dropping over the outfall weir sufficient aeration is obtained to float some of the lighter solids. To clean up the effluent water a skimmer, similar to that installed in the influent channel, was placed in the effluent channel. A sump was placed next to the channel to collect the skimmed material for pumping to the sludge ponds. The operation of the pump is controlled by a float-operated switch. The installation operates continuously.

Other minor operating difficulties have been experienced, but are only of the expected type. Some trouble was encountered in pumping the recovered oil to the refineries. After the pump suction had plugged many times, a small basket-type filter was installed at the pump suction. Later a large twin-basket filter was installed in the discharge line from the skimmed-oil pumps to the storage tanks.

Results of Operation

The installation of the new oil separator was brought about by a realization of the public-health and safety factors involved, as well as by a need for the efficient recovery of oil losses occurring in the refineries. The effect of the refinery effluent on the receiving waters received consideration, and the best possible treatment was desired. To allow for the variations that occur in the sampling and analytical methods, the results of the operation must be viewed on a relative basis. In evaluating the accumulated data, absolute values are of little utility except to provide a basis upon which the difference can be determined. The effectiveness of the separator has been measured by relying upon large numbers of spot samples analysed by the accepted API method. In the following presentation the results of the separator operation are given on a percentage basis, developed from the average values of a large number of individual samples and analyses.

The first indication of the effectiveness of the new installation was a notable increase in the amount of oil and emulsion skimmed from the separator. The nature of the total skimmings indicated that about 250 to 300 barrels per day of heavy emulsion was being retained by the new separator. Previously this material had passed through the old separator and had accounted for the high oil content of the total effluent. The results of later tests showed that the oil content of the total refinery effluent was reduced by 80 to 85 percent. The increase in the volume of separator skimmings and the nature of the material overloaded the existing oil-recovery facilities. As a result, the emulsion-treating facili-

ties were improved and relocated in the separator area.

A study of the accumulated data shows that the oil content of the waste water is reduced gradually throughout the system. The initial separation of oil occurs in the collection system and in the open culvert. By the time the water enters the distribution chamber, the surface is covered with free oil. The relative amount of oil dispersed in the water is shown in Table 10. At the first sampling point in the open culvert about 60 percent of the oil is suspended in the water. The oil content of the water phase is reduced further in the open culvert and influent channel. At the inlet to the distribution chamber only 20 percent of the oil is dispersed in the water. About 80 percent of the oil has collected at the surface. The water entering the final chambers contains only about 15 percent of the original oil content. The total effluent from the oil separator contains about 5 percent of the total amount of oil. The new oil separator recovers and retains about 95 percent of the oil which enters the collection system serving the refineries.

In Table 11 a similar set of relative values is presented for the sedimentation occurring in the new facilities. The turbidity of the river water used in the refineries is relatively high. The suspended-solids content of the raw waste water shows about 300 percent increase over the intake water. The velocity of the water in the open culvert and influent channel is sufficient to prevent any large accumulation of sediment. All solids are carried into the separator proper. The analytical data show that about 50 percent of the settleable solids are collected in the sedimentation chambers of the distribution

TABLE 10
Removal of Oil: Oil Separator—Toledo Refinery
(Basis: Process water = 26,500 gpm.)

Point in System	Surface Oil (Percent by Volume)	Dispersed Oil (Percent by Volume)
Inlet of open culvert	40	60
Inlet of distribution chamber	80	20
Inlet of final chambers	85	15
Outlet of final chambers	..	5

TABLE 11
Removal of Sediment: Oil Separator—Toledo Refinery
(Basis: Process water = 26,500 gpm.)

Point in System	Settled Solids (Percent by Volume)	Suspended Solids (Percent by Volume)
Inlet of open culvert	..	100
Inlet of distribution chamber	..	100
Inlet of intermediate chambers	50	50
Inlet of final chambers	65	75
Outlet of final chambers	75	25

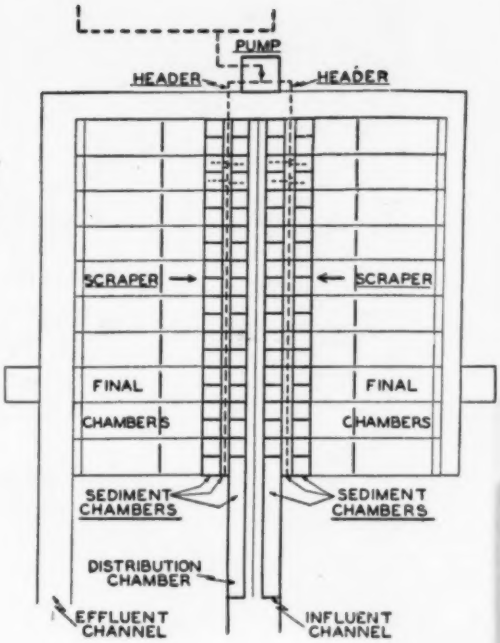


Figure 7—Sludge-Handling System, Oil Separator at Toledo.

chamber. Of the remaining 50 percent of total suspended solids about 15 percent are collected in the intermediate chambers, and an additional 10 percent are settled in the final chambers. The total effluent from the oil separator contains about 25 percent of the suspended solids present in the raw waste water. In this instance the average value is comparable to that of the suspended-solids content of the receiving waters. Normally the pH of the refinery effluent approaches that of the receiving waters. The pH of the river water varies from 7.0 to 7.5. The separator effluent follows in the same pH range.

Conclusion

In the design of a new oil separator to serve these Toledo refineries, the controlling factors were:

1. Effectiveness.
2. Low available head.
3. Large volume of waste water.
4. Economy.

Basically, the separator was sized by the methods outlined in the API manual, *Disposal of the Refinery Wastes*. In accomplishing the final design, several modifications were included as a means of satisfying the factors noted previously herein. Although two-stage oil and sediment removal is provided, in effect a unitary chamber was installed. The separator was designed to handle 35,000 gpm. of process waste water and 10,000 gpm. of rainfall runoff.

In testing the operation of the new oil separator after construction, the characteristics of the waste water were found to differ from the data used for the original design. The maximum process waste-water flow was only 26,500 gpm., and the gravity of the oil was 27.0° API. Using these actual conditions, the oil separator has a capacity to handle the maximum process waste-water flow of 26,500 gpm. plus about 20,000 gpm. of rainfall runoff. Inasmuch as the rainfall runoff exceeds 20,000 gpm. only about 10 hours per year, the separator is adequate for the present. The construction of additional chambers or impounding tanks is still under consideration as a means of handling abnormally high volumes of rainfall runoff.

Over a period of time a normal operating procedure was developed for the new oil separator. Increased recovery of oil was apparent from the time the new facilities were placed in operation. The new oil separator was effective, and recovered 95 percent of the oil from the waste water. The effluent from the new separator contained 80 to 85 percent less oil than the effluent from the old facilities. The new oil separator has improved the quality of the refinery effluent as desired, in the interest of public health and safety and in the recovery of oil.

A portion of Anglo-Iranian's 500,000-barrel daily plant at Abadan, Iran, one of the world's largest refineries. (All photos courtesy of The M. W. Kellogg Company.)

World Refineries Built To Meet Varying Needs

"WHAT'S happening in the foreign oil refining field?"

This became such a frequently-put question that The M. W. Kellogg Company decided to devote its Issue 1, 1949 Series of *The Kellogram*, to coverage of the important phases of foreign oil rg-fining activity.

Throughout the world today oil refining techniques vary tremendously because of the different national emphasis placed on particular petroleum products by the various leading oil countries. The article in *Kellogram* seeks to outline and explain these major differences.

In North America, for instance, gasoline is the prime product the crude oil barrel winding up with 45 to 50 percent gasoline. But in Europe fuel oil of various grades is in greatest demand, the total fuel oil stream being about twice as great as gasoline. Thus selection of refining equipment, even more than the crude used, is a prime factor.

At present regular grades of gasoline in Europe range from 70 octane to the low 60's. European refineries, at the same time, are reported to be unable to satisfy the demand for middle-of-the-barrel fractions. Crudes utilized in European refineries, originating mostly from Middle Eastern fields, are wax-bearing mixed paraffinic/asphaltic oils with an API gravity of 32 to 37 and containing 1 to 2 percent sulfur. Approximately 30 percent of the crude distills in the gasoline range and hence this figure is about the minimum yield of gasoline that can be economically produced from such stock. The octane rating, about 40 to 45 ASTM, can be most efficiently improved to the relatively low European octane requirements by thermal reforming. About 35 percent of the crude boils in the kerosine and heating oil range.

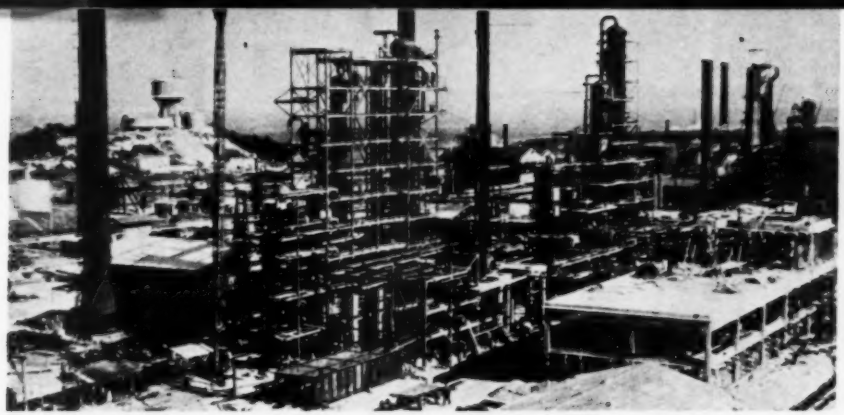
The 35 percent residuum, containing asphalt and wax, is used or processed mainly for fueling ships. One of the processing problems in designing European refineries, the article points out, is the removal or destruction of wax in the bunker oil fraction, the cut just above residual asphalt, without obtaining a larger production of light products than needed. Thus the plants subject the usual bunker oil fraction to carefully controlled pressure and temperature, destroying the heavy molecules in a mild thermal cracking operation. The wax content is thus reduced below allowable limits and the bulk of the smaller molecules formed during the cracking reaction fall in the desirable middle distillate fraction.

Economic considerations, it is pointed out, have delayed up to now installation in European plants of modern, continuous catalytic cracking units. However, now that the number of automobiles needing high-octane gasoline is increasing, European refiners are slanting their long-term planning toward catalytic cracking and catalytic reforming.

In Canada and the U. S. the demand for high quality gasoline is tremendous and American industry is gearing up to produce 80 octane housebrand and 85 octane premium and "will probably reach that goal by the end of 1950" inasmuch as "most new refineries being built in this country are shooting for that level." Here, the article says, such processes as catalytic cracking, alkylation, catalytic polymerization, hydroforming and isomerization—leads the way. As a corollary benefit employment of these processes results in the best utilization of the crude from the standpoint of conservation.

Three of the largest oil companies in Canada now operate or are building Fluid cat crackers, all in the Montreal area. Alberta may see early construction of new refining facilities because of the abundant quantity of high quality crude being found there.

The Kellogram article also touches on the increasing U. S. demand for middle distillates, particularly diesel fuels, heating oils and kerosine. One development



This refinery at Martigues, France, was modernized in the late 30's, was considerably damaged during the war, but is now operating at close to prewar capacity.

outlined is the high-sulfur content of much new U. S. production and the emphasis being given the removal of sulfur from the oil before actual cracking.

Indications are, it is noted, that American refining industry may reach an average of 6 million barrels daily in 1949.

South America also is stressing gasoline volume, Argentina's demand for middle-of-the-barrel requirements, for instance, being quite moderate. Argentina's Yacimientos Petroliferos Fiscales has projected three complete refineries in an effort to provide its needs through its own refineries. "Delayed coking will be utilized to minimize residual oil yield and increase gasoline production. Fluid catalytic cracking to maximize gasoline yields and gasoline quality; catalytic polymerization to prepare additional high octane gasoline from the light gases produced in the cracking reactions and alkylation to produce blending material for aviation gasoline base stocks."

Brazil, with a crude oil lighter than that found in Argentina, although not as light as East Texas, is having Kellogg design and construct a 2500-barrel complete refinery at Bahia, the nucleus of which will be a thermal cracking combination unit. Later on as the demand for gasoline grows, catalytic equipment can be added with economy.

The Venezuelan very active oil situation is described in detail, the American influence and that country's heavy exports being stressed. Several big companies are pouring millions into Venezuelan well drilling and refinery construction.

Chile which is engaging in an intensive search for petroleum "is considering a refinery" to process oil found on the island of Tierra del Fuego. Colombia is producing some 24 million barrels of crude per year but imports all her petroleum products, this due to the country's rugged terrain which "has held back the installation of transportation means" although pipe line construction to overcome this obstacle is now progressing rapidly. The government there is considering installation of capacity to refine a part of the country's production for domestic consumption.

More effective use of the great oil reserves of the Middle East is touched upon in the article which declares "the progress of Western Europe recovery hangs to a great degree upon this scheme."

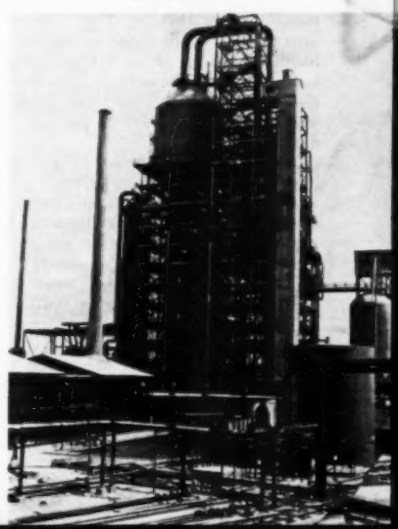
There is small demand for petroleum products in the Middle East and this calls for exportation of nearly everything manufactured by refineries such as that of Anglo-Iranian at Abadan, Iran, one of the two largest in the world, with throughput of about 500,000 barrels daily. Here fuel oil forms approximately 46 percent of the total products. An indication of this emphasis "can be seen in the fact that there is only one catalytic cracking unit being built in this refinery with its huge throughput."

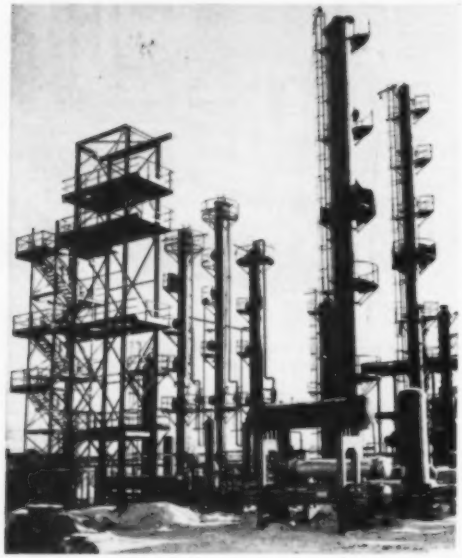
The challenge to the engineer-contractor offered by the refining industry which "is very cognizance of its responsibilities" is noted, it being declared that "he will have to offer more than technical knowledge in design and construction . . . will have to reflect in his recommendations an up-to-the-minute cognizance of changing world conditions and be required to present sound plans for building into refineries, wherever located, a flexibility that will permit refiners to operate advantageously under a wide variety of crude supply and market demand situations."

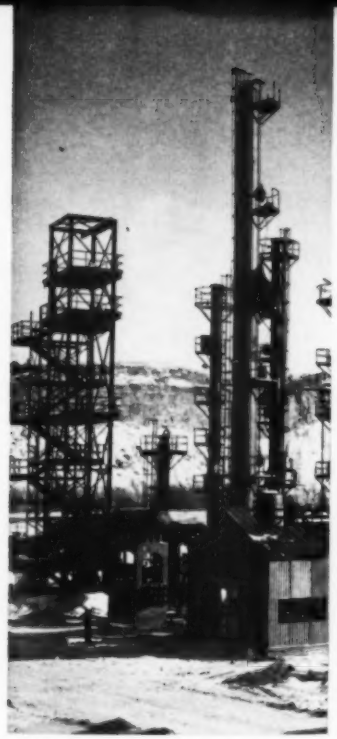
Partial Analyses of Typical Crudes

SOURCE	East Texas	West Texas	Eastern Venezuela	Iran	North Sumatra
Crude Oil					
Gravity—°API	38.1	32.4	32.2	32.8	47.8
Sulfur—Weight percent	0.33	1.86	1.08	1.6	0.1
250° EP Naphtha					
Volume Percent Crude	21.8	15.7	12.0	14.8	30.0
Gravity—°API	71.0	63.7	70.0	73.0	62.5
Sulfur—Weight Percent	0.01	....	0.02	....	....
RVP	7.0	8.0	....	....	....
CFR—M	68.5	67.2	70.0	68.0	....
250—400° Naphtha					
Volume Percent Crude	16.2	17.8	15.0	14.4	38.0
Gravity—°API	48.0	48.5	56.0	48.0	52.0
Sulfur—Weight Percent	0.027	0.3	0.06	0.2	....
RVP	....	....	....	....	....
CFR—M	43.6	39.9	48.4	46.0	....
Total Naphtha—400° EP					
Volume Percent Crude	38.0	33.5	27.0	29.2	68.0
Gravity—°API	60.5	55.3	62.0	59.9	56.5
Sulfur, Percent Weight	0.016	0.2	0.04	0.1	....
CFR—M	57.9	57.2	58.0	57.2	....
400-500° Kerosene					
Volume Percent Crude	10.0	8.5	10.0	10.0	12.0
Gravity—°API	39.0	39.5	39.0	35.7	41.2
Sulfur—Weight Percent	0.043	0.3	0.2	0.6	....
500-600° Gas Oil					
Volume Percent Crude	10.0	8.5	11.0	8.0	8.0
Gravity—°API	36.5	33.3	34.0	32.5	35.0
Sulfur—Weight Percent	0.06	1.4	0.58	1.0	....
600-700° Gas Oil					
Volume Percent Crude	9.5	11.0	9.5	10.0	....
Gravity—°API	32.0	29.0	30.0	27.0	....
Sulfur—Weight Percent	0.33	2.1	0.88	1.9	....
Residuum					
Volume Percent Crude	32.5	38.5	42.5	39.4	12.0
Gravity—°API	19.3	17.8	20.0	13.4	21.4
Sulfur—Weight Percent	0.77	3.4	1.98	2.8	....

Lago Oil Transport Company's Fluid Cat Cracker at Aruba was one of first (1943) to go on stream.







Gas Recovery Unit at Conoco's Billings Plant. At left, structure for catalytic polymerization cases; center, after-fractionators for liquid petroleum products and stabilized polymer gasoline; right, feed preparation towers.

Unique Operating Units At Conoco's Billings Plant

OPERATING units termed "unique in contrast to conventional processing methods" are incorporated in Continental Oil Company's $9.5 million refinery at Billings, Mont., scheduled for completion in October, 1949. The refinery has been designed to handle a blend of crudes of such high sulfur and asphalt content as to prohibit processing in the usual methods. Design capacity is 6800 barrels per calendar day.

The plant is designed to process high-sulfur (2.2 weight percent) and low gravity (28° API) crude consisting of 60 percent of Elk Basin crude (29.6° gravity) and 40 percent of light Frannie crude (26.5° gravity).

The new plant, located near the Yellowstone River, is being built on a 118-acre tract which allows ample room for expansion.

The flow plan calls for crude to pass through conventional heat exchange equipment and a large oil heater into a single flash tower at 800° F. From this primary tower all light oils through 600° end point diesel oil will flow as a vapor through the desulfurizing reactor to a single fractionator.

The latter tower will produce a 250° F. end point product overhead, which is subsequently stripped of butanes and lighter in a stripper stabilizer.

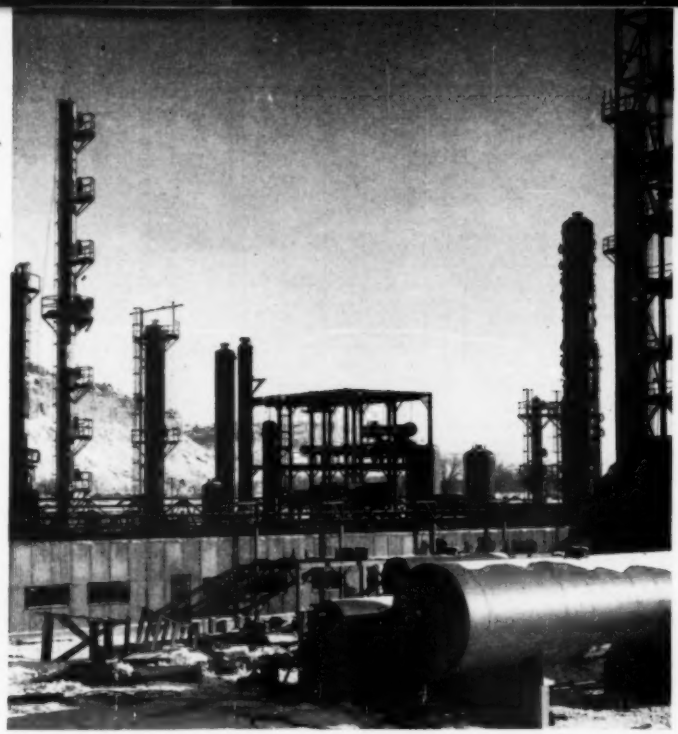
Four strippers are provided for side stream distillate cuts from the secondary tower. Part of the heavy side cuts and all of the bottoms containing catalyst fines will be returned to the catalytic cracker. The desulfurizer will operate at about 700° F. and will circulate about 25 tons an hour of catalyst. This light oil portion of the crude represents approximately 47 percent of the charge. This method of eliminating the boogie factor in processing high sulfur crudes is a new approach to an old problem.

An unstripped virgin gasoil side stream comprising 15 percent of the crude charge will be taken from the primary crude tower for catalytic cracking charge.

The remaining 38 percent bottoms stream from the primary crude tower will flow directly into the propane deasphalting unit. Here propane at some 17,000 barrels daily or a 5.7 ratio to charge will separate about 2000 barrels daily of virgin gasoil from the 1000 barrels daily of asphalt in the 3000 barrels daily of topped crude.

In order to keep the propane liquefied, the treating tower will operate at about 600 pounds pressure. Two liquid phases will exist in this tower; the upper phase will contain the lighter gravity mixture of gasoil in solution in the bulk of the propane; the lower phase in the bottom of the tower will be asphalt containing a small amount of propane. The tower top will be controlled at about 260° by steam flowing through eight internal coils and the topped crude feed entering near the top. The tower bottom will be maintained at approximately 160° F. by controlling the propane streams temperatures as they enter the tower at three points near the bottom.

After leaving the treating tower the top or raffinate stream of gasoil will be stripped of propane in three successive towers operating at 300 pounds,



Control Building for Gas Recovery Section. Right, portion of catalytic cracking structure: left (on opposite page), towers of gas recovery equipment.

200 pounds and 5 pounds, then flow to the catalytic cracker. The asphalt bottom stream will flow through the only other oil heater, a small vertical furnace, to its 200-pound and the 5-pound strippers. The asphalt leaving the 5-pound stripper will either be sold as such or blended with cycle stock to fuel oil specifications. The propane vapors from the 5-pound strippers will be compressed to 200 pounds and join the other overhead streams. These vapors will then be condensed and recirculated.

The fluid cracking unit is of the conventional design except that a second reactor, the desulfurizer, has been added. One regenerator 23 feet by 50 feet will operate with both reactors. As mentioned before, 25 tons an hour of catalyst will be circulated through the desulfurizer. In addition, 500 tons per hour will be circulated in the catalytic cracker. The initial catalyst charge will be 175 tons of silica-magnesia type catalyst. Feed to the catalytic cracker will consist of about 2000 barrels daily of heavy gas-oil from the deasphalter, 1100 barrels daily of unstripped virgin gasoil from the primary crude tower and 650 barrels daily from the secondary crude tower making a total fresh feed of 3750 barrels daily. Total case charge will be 8550 barrels daily including the 4800 barrels daily of recycle. The reactor temperature will be 900° F. The structure for this unit is 150 feet high.

The vapor recovery system will recover the propane-butane fraction from all plant gases as feed for the catalytic polymerization unit. A novel feature here is the double contactor tower system used in the H_2S removal unit. The vapor from the first stage compression discharge drum will be contacted with diethanolamine solution in one tower then compressed through the second stage to the final 260 pounds pressure. Liquid from the first stage discharge drum will be contacted with diethanolamine in a second tower then will rejoin the vapors from the second compression stage before entering the fractionators.

The catalytic polymerization unit and after fractionators are of the conventional type for recovery of LPG propane-butane and stabilized catalytic polymerization gasoline. Two tubular reactors using a steam generating system for temperature control will be employed.

The desulfurized straight run gasoline and catalytic gasoline will be sweetened in a treating unit rated at 4750 barrels daily capacity. The butanes will be treated in a twin case 500 barrels daily unit. Distillates will be doctor sweetened.

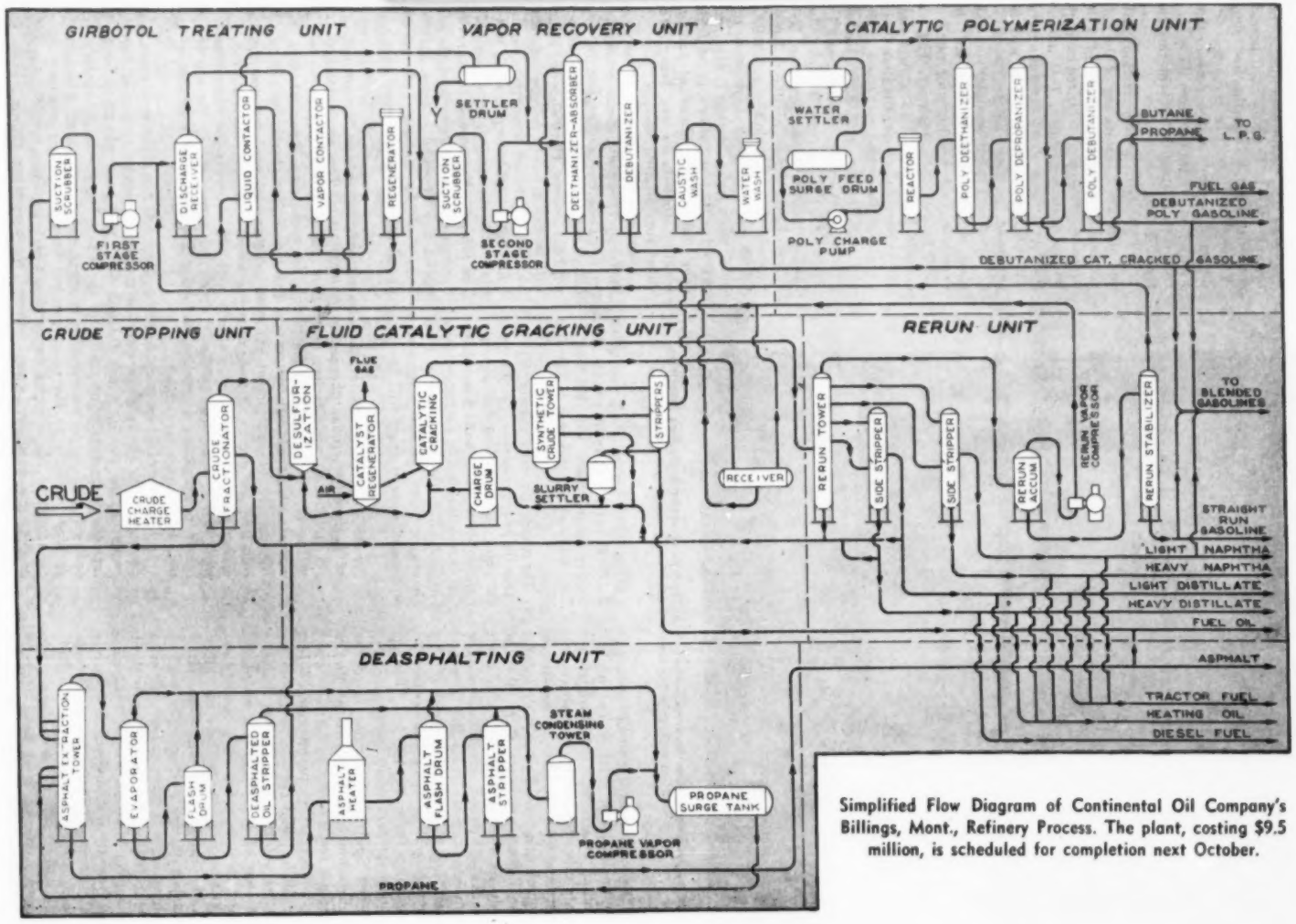
A total tankage of 438,000 barrels is being provided for finished and intermediate storage in 30 tanks. Included in this group are five 500-barrel LPG tanks, a 10,000-barrel spheroid for casinghead, a 120,000-barrel base gasoline tank and the usual other tanks. Storage is also provided for 10,600 gallons of sulfuric acid and 12,000 gallons of caustic. Floating roof tanks are being provided for gasoline storage.

Steam for the plant will be produced in 175-pound steam generators on the catalytic cracker and by two 650-pound-pressure, 90,000-pound-per per-hour boilers. The 650-pound steam will be expanded to 175 pounds and 40 pounds through the drivers on the boiler fans, water pumps and air turbo blower on the catalytic cracking unit. The 175-pound steam will be expanded through other drivers to feed the 40-pound and 20-pound systems. Process heating will be done with 175- and 40-pound steam. Forty-pound steam will

***IN RECENT YEARS** there has been a steady increase in the amount of high-sulfur crudes charged to refinery units. The great demand for petroleum products has resulted in the increasing utilization of stocks formerly considered unsuitable for processing. Principal difficulties associated with processing the high-sulfur stocks have been the very serious equipment corrosion problems encountered and the relatively low quality of some of the products when conventional processing methods were used. Refiners with the necessity for operations with sour crudes have gradually developed experience in the use of alloys for equipment protection, and many plants have achieved reasonably satisfactory techniques.*

In this new plant an entirely new approach to the problem is made. Equipment for the catalytic desulfurization of a major portion of the crude oil, all the light oils through 600° end point gasoil, is built into the crude distillation portion of the plant. The powdered cracking catalyst used for desulfurization is regenerated in a vessel which is devoted primarily to the spent catalyst from a cracking reactor.

Because of the extreme importance which facilities handling sour crudes now have for many refiners, the operating results finally achieved by this new plant will be of especial interest.



Simplified Flow Diagram of Continental Oil Company's Billings, Mont., Refinery Process. The plant, costing $9.5 million, is scheduled for completion next October.

Left to right: Brick stack and two boilers; crude heater with metal stack; primary crude tower; deasphalting tower; catalytic cracking unit; and gas recovery unit, all at Conoco's Billings, Mont., plant.

be used for process stripping. Utility heating will be done with 20-pound steam. Condensate will be returned through a high-pressure hot system and a low-pressure cold system.

One of the interesting angles in the corrosion-resistant tower linings for many of the units is the use of clad sheets requiring only one seam weld. A light sheet of 11-13 chrome steel or similar alloy is fused at the mill to a heavier sheet of steel to provide strength in making clad materials. The bi-metallic sheet can then be fabricated as though it were a solid sheet of corrosion-resistant metal. This type of material has been used in making all of the larger equipment with a sizable saving in fabrication costs as compared to lining the vessels in the customary manner.

The refinery is designed to produce from the crude mixture mentioned previously approximately 58 percent of 10-pound Reid vapor pressure gasoline with clear unleaded octanes of 73.5 Motor method and 80 by the Research method. Design yields of other products are:

LPG — Propane and Butane	3.5%
Middle Distillates	15.0%
Fuel Oil and Asphalt	22.0%

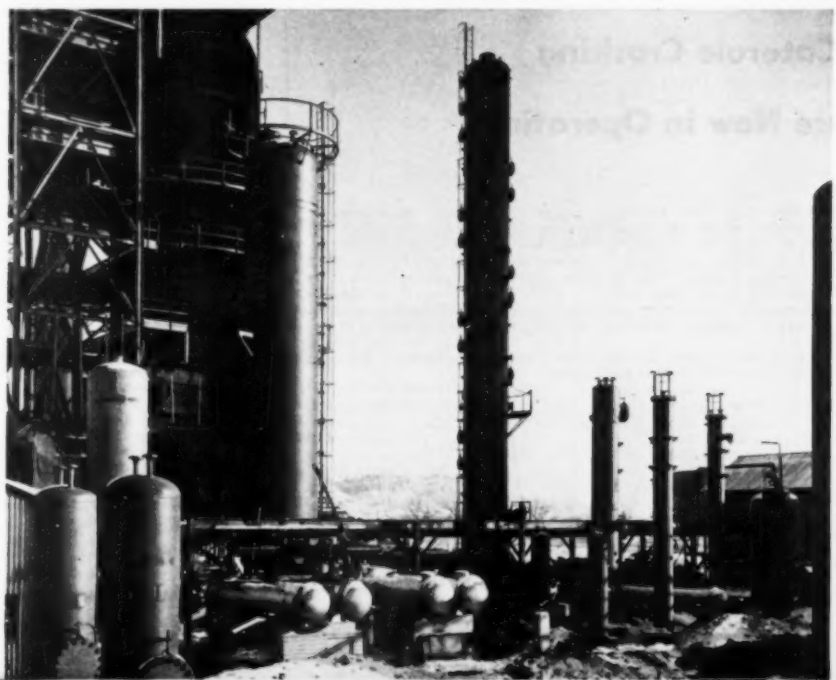
Situated along the west side of the plant are the truck-loading rack, with a capacity for loading four transport trucks simultaneously, the marketing warehouse, 12 double-spot tank car loading rack, the refinery warehouse and mechanical offices and the refinery office.

Operating units are located in the approximate center of the refinery. Two 120,000-barrel crude tanks, the flare and the water-cooling tower are south of the operating area.

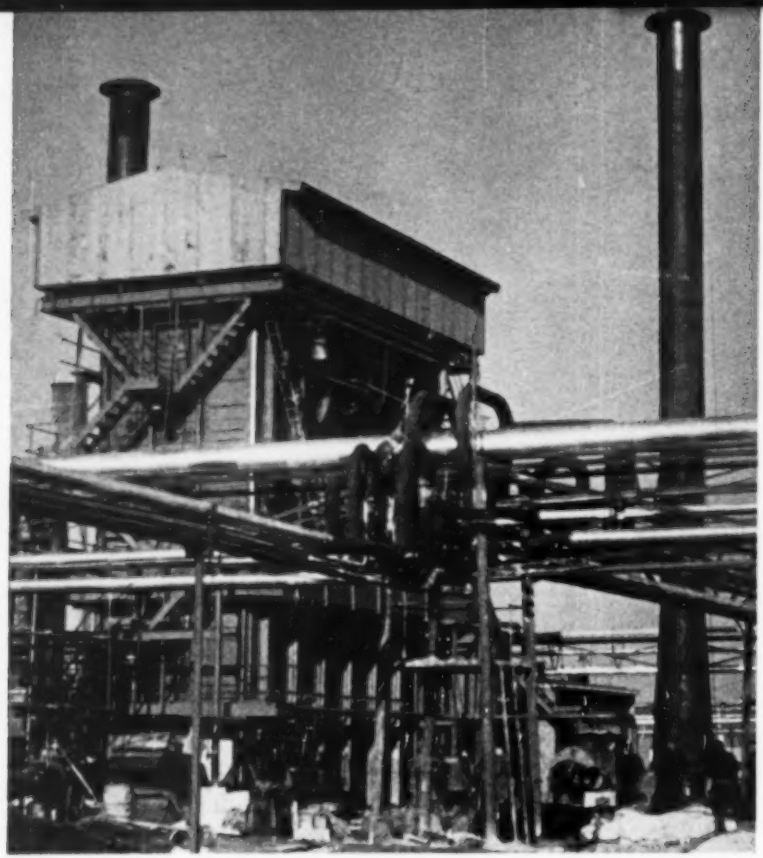
The oil separator is located to the east of the units toward the river. To the north are the treating systems, LPG tanks, rundown, blending and finished product storage tanks.

Construction of the refinery is by Jones and Laughlin Company as the major contractor. The Chicago Bridge and Iron Company is building the tanks.

Despite adverse weather, Conoco officials said that plant construction is moving at a satisfactory schedule.



In the structure at left is the catalyst regenerator. Next tower to right is the deasphalting tower. In center is the primary crude tower. Auxiliary equipment for the deasphalting unit is shown in foreground.



A Catarole Cracking Furnace

First Catarole Cracking Furnace Now in Operation

PETROCHEMICALS Ltd., London, which recently started up the first cracking furnace of its plant for producing chemicals from petroleum at Partington, near Manchester, England, has announced that the unit is working satisfactorily and treatment of the raw material is at a rate in excess of nominal capacity.

"From the beginning of operation the quality of the products, both liquids and gases, has been up to specification and the yield of the olefinic gases which constitute the valuable part of the gaseous product is higher than expected," officials declared. "The throughput is in excess of the rated capacity. Delivery of gases to the Manchester Corporation Gas Works has commenced."

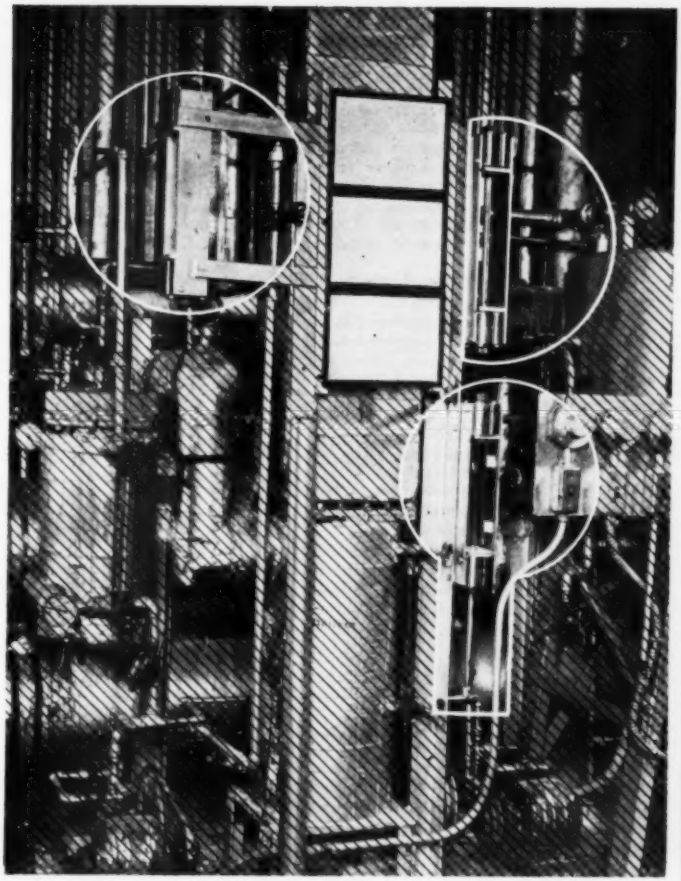
The Catarole process converts an essentially non-aromatic charging stock derived from petroleum into the full range of aromatic hydrocarbons, formerly obtaintable only from coal tar, and into gases rich in olefins. The process is said to be the first of its kind to be developed anywhere and is entirely a British invention, it having been developed from the pilot plant stage by Petrocarbon Ltd., which also has been solely responsible for the design, construction and erection of the large-scale plant.

The Catarole cracking furnaces transform the charging stock—a petroleum distillate—into liquids and gases which are processed in subsequent plants to yield finished chemicals. The gas yield is even higher than was at first anticipated. The gas is of high calorific value and part of the output is being piped direct to the Manchester Corporation Gas Works to blend with the city's gas supply. It is estimated that this arrangement will save the Manchester Gas Department a capital expenditure of $1 million and about 53,000 tons of coal per year, which would have been required to produce the additional quantity of gas needed to meet the gas shortage in the area.

The $18 million all-British designed and British-built Petrochemicals plant employs the Catarole process—an invention originated and developed in England which enables the production of more than 70 different chemicals from the liquids and gases derived from petroleum. The chemicals are raw materials used in the manufacture of paints and varnishes, rubber and plastic products, dyestuffs, detergents, drugs, anaesthetics, pharmaceuticals, special fuels and numerous other commodities, many of which will find their way into England's export trade.

"Until now," company officials declared, "many of these chemical raw materials have been either imported from dollar areas or produced by less economic or less productive methods. A number of the chemicals have never been available in Britain, in bulk, before.

"All royalties for the patents, etc., for the process are payable in the United Kingdom. No foreign currency has been required for materials, 'know-how' or design."



With the exception of the tubes, all three rotameters shown in the accompanying photo were fabricated completely in the shops of the University of Texas Bureau of Industrial Chemistry. Meter in upper right circle is a standard type, below it is meter No. 2 with extension well. No. 3, upper left, shows wide view of standard type. At the top center appear calibration charts for the three meters. (Photo by R. Pat Lightfoot.)

The Calculation of Rotameters

WALTER B. HOWARD
Bureau of Industrial Chemistry
The University of Texas, Austin

***WELL DESIGNED** rotameters are available commercially and are being increasingly used in process plant flow measurement. In this article the author presents a system of design equations not available in the literature, with the expectation that they will prove useful in the modification of existing meters to fit changed operating conditions and in the design of new meters for plant-fabrication if occasion demands. An increased understanding by engineers generally should promote the wider application of this useful instrument.*

THE use of variable area, constant head flow meters is rapidly expanding in the various process industries. Although several types of meters involving the variable area principle have been suggested,[5, 7] the type most generally employed at present is that commonly known as the rotameter.* Certain of its unique properties make it peculiarly suited to many metering problems[3] otherwise difficult or impossible to solve by means of other rate of flow instruments. Noteworthy among these properties are those which make practicable the fabrication of many rotameters immune to effects due to changes in fluid properties such as density or viscosity or both.

In spite of the increasing use of rotameters, however, readily usable design equations are not available in the literature. While it is true that well-designed rotameters are available commercially, yet it is felt that a system of simple equations would aid in the general understanding of rotameters and in turn would increase their popularity.

The close prediction of rotameter operating characteristics has been made possible by the development, largely by the rotameter manufacturers, of float shapes tending to give nearly constant discharge coefficients

* Fischer & Porter Co. has recently adopted the trade name "Flowrator" to designate its product.

NOMENCLATURE

A_T = annular area between float and tube at large end of active metering taper, sq. in.
A_t = annular area between float and tube at small end of active metering taper, sq. in.
C = discharge coefficient, dimensionless.
D_e = equivalent diameter, ft.
D_F = greatest diameter of float, inches.
D_T = internal diameter of plain tube, or r.m.s diameter of beaded tube, at large end of active metering taper, inches.
D_t = internal diameter of tube at small end of active metering taper, inches
g = acceleration of gravity, 32.17 ft./sec.^{2}
H = fluid head, ft.
h_f = fluid head, expressed as inches of fluid
h_w = fluid head, expressed as inches of water.
q = fluid flow rate, g.p.m., when float at some tube elevation corresponding to a certain taper diameter.
q' = fluid flow rate, gravimetric units.
q_{max} = fluid flow rate, g.p.m., when float elevation is at large end of active taper.
q_{min} = fluid flow rate, g.p.m., when float elevation is at small end of active taper.
r = ratio of maximum to minimum flow rates through meter.
Re = Reynolds number, dimensionless.
V = velocity of fluid flow, ft./sec.
W_F = float weight, grams.
μ = fluid viscosity, lb./(ft.) (sec.).
μ' = fluid viscosity, centipoises.
ρ_F = specific gravity of float relative to water, or density in g/cc.
ρ_f = specific gravity of metered fluid relative to water, or density in g/cc.
ρ'_f = fluid density, lb./ft.^{3}

over wide ranges of Reynolds number values, extending to values below 100.[3] In contrast with the old plumb-bob float, the various types of "viscosity immune" floats present relatively little surface for drag while also tending to eliminate streamline flow in the lower Reynolds number region. The newer type floats are characterized by a "head" having a relatively sharp edge,[2] as thin as 0.005 inch for small floats, at the zone of greatest float diameter forming the inner circle of the active metering annulus between float and tube, and by a relatively small ratio of "body" diameter to "head" diameter. The sharp edged head of the float may be in the form of a disc sharpened from the upper side of the disc, thus forming a frustum of a cone with apex above the float, or it may be in the form of a frustum of a conical shell, again having an apex above the float, and with the lower edge of the shell frustum sharpened to form the circle of greatest diameter. This "umbrella" head usually has an included angle of 90° to 110° on the upper side, and 90° to 140° on the lower side. In general, the "umbrella" head type is immune to discharge coefficient change down to a lower Reynolds number than the disc type.[4] Both types of heads may be used with any of the body types to be described below.

The values of the flow coefficient, and of the minimum Reynolds number above which the discharge coefficient is essentially constant, are dependent upon both the head type and the body type. The values which are quoted below are based on the scant technical information available,[4] on the analysis of performance characteristics of a number of commercial models, and on experience gained through the design, by the author, of approximately twenty rotameters which were constructed and calibrated in this laboratory. The float body types commonly used for viscosity immune floats are as follows:

Type 1 (Figure 1a): Float body integral with float head; central guide wire employed to stabilize float. Discharge coefficient, C, is usually in the range of 0.60 to 0.65 for floats in gases; 0.60 to 0.75 for density compensated floats (rotameter calibrated in weight units and employing a float having a density twice the mean fluid density) in liquids; and 0.60 to 0.70 for those floats having densities substantially greater than twice the liquid density. In the last instance the effect of viscous drag is small on account of the smaller float weight required as the ratio of float density to fluid density increases, and on account of the smaller body diameter and surface drag of a float as float density increases. The minimum Reynolds number for constant discharge coefficient is usually of the order of 100 to 300.[4]

Type 2 (Figure 1b): Float having a perforated guide disc connected to float head by means of a stem, in which type the stem compares with the body of Type 1 float in producing weight as well as viscous drag. The area of perforations in the guide disc should be as great as possible. The guide disc is usually at the bottom of the float. This type of float is usually used in a tube having three or more internal longitudinal ridges or beads, which are integral with the glass tube, for stabilization of the float. Such tubes may be secured from at least four manufacturers. The discharge coefficients and minimum Reynolds numbers have approximately the same ranges as do the corresponding values for the Type 1 floats.

Type 3 (Figure 1c): Float consisting of float head connected by means of a long, small diameter rod to a float body located within a stagnant portion of the metered fluid contained in an extension chamber below the metering tube. A beaded tube furnishes a convenient means of guiding the float head. Since this type float presents relatively little surface to the fast moving fluid, it has a greater degree of viscosity immunity than those types having a float body located in the tapered metering tube. As a result, its discharge coefficient is usually in the range of 0.60 to 0.65 for both density compensated and non-density compensated floats in both gases and liquids. The minimum Reynolds number for constant discharge coefficient is usually of the order of 40 to 100.[4]

It should be emphasized that though the above values are approximate, yet they are sufficiently close for design purposes since rotameters are usually designed to operate over ranges somewhat greater than those defined by anticipated maxima and minima of flow rates. It should also be emphasized, in cases of Type 1 and Type 2 floats, that the effect of viscous drag on the float bodies of such floats will vary with relative physical dimensions of float and with liquid viscosity. Hence flow characteristics cannot be predicted as closely as in the case of Type 3 floats. In general it is suggested that the body, or stem, diameters of Types 1 and 2 floats be not much greater than one-half the head diameters.

The predictability of discharge coefficients, nearly constant over the metering range, makes possible the de-

sign of rotameters by means of a few simple equations. The rotameter equations originally developed by Colburn and Schoenburn[6] from the Torricelli equation are somewhat unwieldy for rapid design calculations. The equations here presented make rotameter design simple and straightforward.

1) Float Diameter

Assuming a constant discharge coefficient throughout the entire metering range of a rotameter, the flow of fluid through the meter will vary linearly with the annular area between tapered tube and float. Since tapered glass tubes are readily and cheaply available, from about a half dozen manufacturers,* only in certain definite sizes, float diameters must be determined on the basis of the dimensions of available tubes and the ratio of maximum to minimum design flow rates (float in top and bottom ends, respectively, of active taper portion of metering tube). That ratio is also the ratio of maximum to minimum annuli. Thus we obtain the equations for minimum and maximum annular areas:

$$A_t = \frac{\pi D_T^2 - \pi D_F^2}{4}$$

$$\text{and } A_T = \frac{\pi D_T^2 - \pi D_F^2}{4} = r A_t$$

$$\text{Hence } D_F = \sqrt{\frac{r D_t^2 - D_T^2}{r-1}} \qquad (1)$$

Since common tolerances on internal taper diameters are ± 0.0004 inch, a comparably close finish is called for in constructing the major float diameter. Most precision bore tapered tube manufacturers express tube diameters in inches and fractions thereof. In a given tube size range, there are usually several available tapers, so that extreme variations of flow requirements can be handled. Thus, the smaller the value of r, the slimmer, in general, should be the tube taper.

2) Float Weight

After float diameter has been calculated, float weight is determined by the equality relation between pressure drop produced by the fluid flowing upward through the annulus, according to the Torricelli equation, and the pressured drop produced by the apparent weight of the float distributed over the cross sectional area of the float at its greatest diameter (i. e., equality of kinetic and potential energies).

* Ace Glass Inc., Brooks Rotameter Co., Commercial Research Laboratories, Inc., Fischer & Porter Co., Fish-Schurman Corp., Schutte & Koeting Co., Scientific Glass Apparatus Co., Inc.

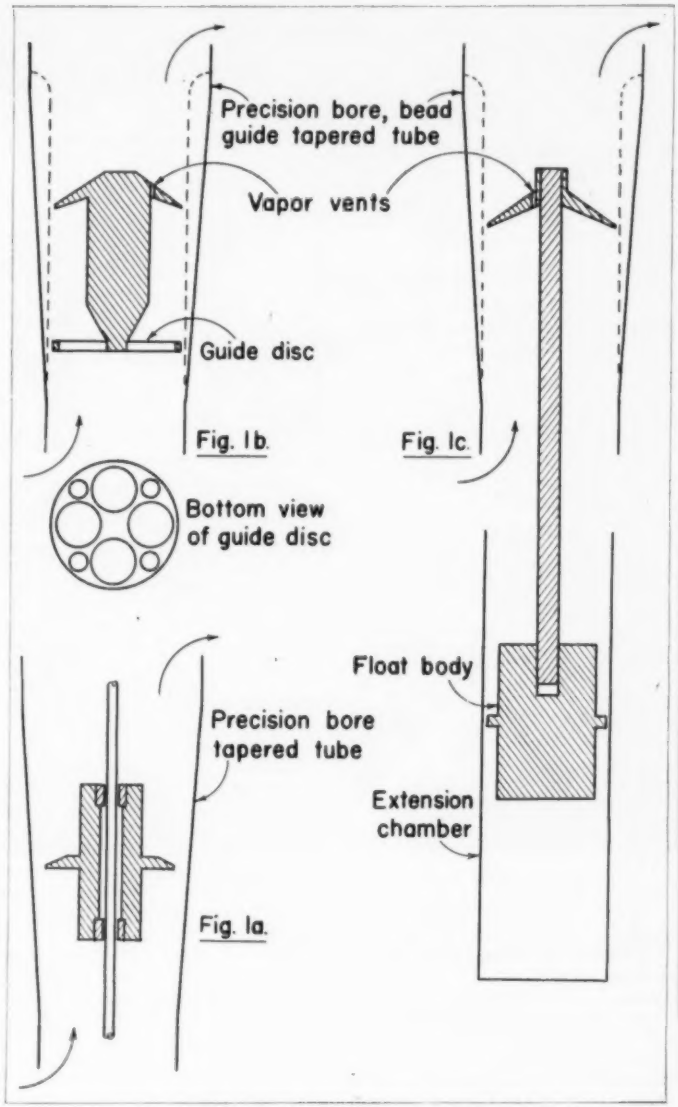


FIGURE 1. Basic Rotameter Float Shapes

For the velocity term in the Torricelli equation, $V = C\sqrt{2gH}$, may be written by inspection

$$V = \frac{(231)(q_{max})}{(\pi/4)(D_T^2 - D_F^2)(12)(60)}$$

$$\text{Hence } h_f = \frac{(231^2)(q^2_{max})}{(C^2)(2g)(0.7854^2)(D_T^2 - D_F^2)^2(12)(60^2)}$$

$$\text{or, } h_f = \frac{0.0311\, q^2_{max}}{(C^2)(D_T^2 - D_F^2)^2} \qquad (a)$$

Also, pressure drop across float is determined by the ratio of apparent float weight to greatest float cross section.

$$\text{Apparent float wt.} = \frac{W_F(\rho_F - \rho_f)}{\rho_F}$$

$$\text{Hence } h_f = \frac{(W_F)(\rho_F - \rho_f)(27.7)}{(453.6)(D_F^2)(\pi/4)(\rho_F)(\rho_f)}$$

$$\text{or, } h_f = \frac{(0.0778)(W_F)(\rho_F - \rho_f)}{(D_F^2)(\rho_F)(\rho_f)} \qquad (b)$$

Equating the two expressions for h_f

and solving for W_F,

$$W_F = \frac{(0.400)(q'^2_{max})(\rho_F)(\rho_f)(D_T^2)}{(C^2)(D_T^2 - D_F^2)^2(\rho_F - \rho_f)} \quad (2)$$

By inspection may be written

$$W_F = \frac{(0.400)(q'^2_{min})(\rho_F)(\rho_f)(D_T^2)}{(C^2)(D_T^2 - D_F^2)^2(\rho_F - \rho_f)} \quad (2a)$$

Float weight is expressed in grams since it is usually most easily checked on a simple analytical balance, which latter is normally supplied with weights in the c.g.s. system.

3) Pressure Drop Across Float

From equations (a) and (b) above may be written the following equations for pressure drop:

$$h_f = \frac{(0.0778)(W_F)(\rho_F - \rho_f)}{(D_F^2)(\rho_F)(\rho_f)} \quad (3)$$

$$h_a = \frac{(0.0778)(W_F)(\rho_F - \rho_f)}{(D_F^2)(\rho_F)} \quad (3a)$$

$$h_t = \frac{(0.0311)(q'^2_{max})}{(C^2)(D_T^2 - D_F^2)^2} \quad (3b)$$

4) Reynolds Number

The general form of the Reynolds number equation is as follows:

$$Re = \frac{D_e V \rho_f'}{\mu}$$

As in the derivation of equation 2, the velocity term may be written

$$V = \frac{(0.4085)(q_{max})}{(D_T^2 - D_F^2)}$$

For an annulus

$$D_e = \frac{D_T - D_F}{12}$$

$$\text{Also } \rho_f' = (\rho_f)(62.43)$$

$$\text{And } \mu = 0.000672\mu'$$

$$\text{Hence } Re = \frac{(3163)(q_{max})(\rho_f)}{(D_T + D_F)(\mu')} \quad (4)$$

Similarly, by inspection may be written

$$Re' = \frac{(3163)(q_{min})(\rho_f)}{(D_T + D_F)(\mu')} \quad (4a)$$

5) Viscosity Ceiling

In order to determine the maximum viscosity at which a rotameter may be operated, (4a) is rewritten in the form

$$\mu'_{max} = \frac{(3163)(q_{min})(\rho_f)}{(Re_{min})(D_T + D_F)} \quad (5)$$

For the term (Re_{min}) is inserted the value of the lowest Reynolds number above which the discharge coefficient of the rotameter is essentially constant. As previously explained, this value is usually of the order of 50 to 200 for sharp edged floats of the types described above.

6) Discharge Coefficient

In order to interpret experimental data, etc., equation 2 may be solved for C, as follows:

$$C = \frac{(0.633)(q_{max})(D_F)}{D_T^2 - D_F^2}\sqrt{\frac{\rho_f \rho_F}{W_F(\rho_F - \rho_f)}} \quad (6)$$

By inspection may be written

$$C = \frac{(0.633)(q_{min})(D_F)}{D_T^2 - D_F^2}\sqrt{\frac{\rho_f \rho_F}{W_F(\rho_F - \rho_f)}} \quad (6a)$$

A special case not covered by the above equations is that in which it is desired to meter flow rates over a range from a maximum value down to essentially zero. In that instance the float diameter is assumed to be as nearly equal to D_t as possible, and W_F is then figured on the basis of that float diameter and the maximum desired flow rate, corresponding to a float position at the top end of the active taper.

It will be seen from the figures that it is customary to drill one or more small vent holes in the tops of umbrella type heads to aid in removal of trapped vapor. The size of such holes is critical when D_F approaches D_t closely. In such a case, the proportion of fluid flowing through the vent hole may be approximated by means of suitable calculations, assuming the hole to be an orifice or a short conduit, and assuming the pressure drop to be that across the float as determined from equations 3 or 3b.

It should also be noted that frictional drag along the sharpened float edge may become a serious factor when the edge thickness is large compared to the radial clearance between float and tube.[1] Consequently a sharp edge is exceedingly important in obtaining a high degree of viscosity immunity.

The float dimensions other than head diameter are based on the density of the float material and the calculated value of W_F, which two factors determine the necessary volume of material in the completed float. The simple formulas of solid geometry are then involved in determining actual dimensions other than head diameter. Special care should be exercised to avoid too much surface exposed to rapidly moving fluids lest effects of viscous drag on float body interfere with constancy of discharge coefficient.

It should be pointed out that the design equations apply equally well to gases or liquids. While expressions of gas rates in terms of gallons per minute, and of gas densities in terms of grams per cubic centimeter, are a bit unusual, yet only the use of simple conversion factors is involved.

From equation 2 may be derived by inspection the equations for correcting fluid rates for changes in fluid density. Thus, in terms of volumetric flow rates,

$$\frac{q_2}{q_1} = \sqrt{\frac{(\rho_F - \rho_{f_2})/\rho_{f_2}}{(\rho_F - \rho_{f_1})/\rho_{f_1}}},$$

or, since volumetric flow rate varies inversely with density of fluid for a given weight rate of flow,

$$\frac{q_2'}{q_1'} = \sqrt{\frac{(\rho_F - \rho_{f_2})(\rho_{f_2})}{(\rho_F - \rho_{f_1})(\rho_{f_1})}},$$

when flow rates are measured in terms of gravimetric units. The latter equation indicates, for example, that in the case of density compensated floats, fluid density changes of as much as 14 percent on either side of the design value will cause an error in gravimetric flow readings of only 1 percent. Thus the extreme usefulness of density compensated floats is obvious.

In those cases where it is necessary to make floats of two materials of different densities in order to obtain an intermediate float density, the relative volumes of the two materials to be used may be determined by means of the following set of simultaneous equations:

$$\rho' x + \rho'' y = W_F,$$

$$x + y = W_F/\rho_F$$

where ρ' and ρ'' are the densities, respectively, of materials *A* and *B*; and x and y, respectively, the volumes.

Methods of connecting rotameter tubes into pipe lines are not discussed here since the construction possibilities are numerous and limited only by the meter application and the ingenuity of the designer.

ACKNOWLEDGMENTS

The author is grateful to Dr. E. P. Schoch, Director of the Bureau of Industrial Chemistry, for his encouragement in the making of rotameters and for his kind permission to publish this material. He is further indebted to several in the constructing and calibrating of the meters designed by means of the equations presented, which served as a check on those equations, as follows: to Dr. W. L. Ray and R. Pat Lightfoot of the same Bureau, for their valuable assistance in making working drawings, calibrating meters, and offering many helpful suggestions; to J. O. Blomke, W. L. Carter, A. Zeh Hurlburt, and A. M. Cuellar for additional calibrations; and to Joe L. McGee, J. W. Roper, and Pinkney Pruitt, of the Bureau, for machining and construction work.

LITERATURE CITED

[1] Brooks, C. H., discussion following article by Schoenborn, E. M., and Colburn, A. P., Trans. Am. Inst. Chem. Engrs., **35**, 359-389 (1939).

[2] Fischer, K., Blechman, S., and Lipstein, E., Trans. Am. Inst. Chem. Engrs., **36**, 857-869 (1940).

[3] Fischer, K., Petr. Ref., **26**, 30-36 (1947).

[4] Fischer & Porter Co., Hatboro, Penn., Catalog Section 98Y.

[5] Kintner, R. C., Ind. Eng. Chem., Anal. Ed., **14**, 261-264 (1942).

[6] Schoenborn, E. M., and Colburn, A. P., Trans. Am. Inst. Chem. Engrs., **35**, 359-389 (1939).

[7] Stout, L. E., and Rowe, A. R., Trans. Am. Inst. Chem. Engrs. **34**, 1-20 (1938).

Transmission Piping for Refinery Steam System

(PART I)

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Figure 1. Typical Refinery Steam Transmission Line.
(Photo Courtesy Crane Company)

LONG steam transmission lines are widely used in refineries. Design of these long lines often becomes a complex problem because so many factors are involved. Complete study of the general design problem and assemblage of all needed data greatly aids in simplifying the work. With such material on hand, the piping or refinery designer can readily solve the usual steam transmission design problem quickly and efficiently.

Satisfactory design of steam transmission piping requires extensive study of the following factors:

1) Pressure loss, 2) pipe size, 3) pipe wall thickness, 4) pipeline heat losses, 5) pipeline expansion, and 6) condensate removal and return.

Regardless of type of service, these factors will be found to be important. Consideration of all factors during design work can be assured by following a standardized procedure. Such a procedure can readily be set up. It will be found a time saver and an aid in design of efficient and economical refinery steam transmission lines.

***STEAM FINDS** important uses in most plants in various process and power applications. The design of the steam systems and steam lines serving these plants, however, is sometimes given less attention than good engineering would indicate. Many factors are involved. Plant complexity, size, age, whether the plant was built as an integrated unit, expanded through carefully planned programs, or just allowed to grow, and so on, are all reflected in the steam distribution facilities of existing plants. In most plants, steam is an expensive utility, but its cost is often overshadowed by larger process items. Steam systems are thus commonly found at all levels between high efficiency with economic operation, and low efficiency with costly, troublesome operation. Few plants claim to have achieved the optimum economic level. Since costs involved frequently reach large totals, the problem is worthy of the careful attention of plant engineers. In this first section of a three part series, the author discusses general factors involved in the complex problem of designing long steam transmission lines for process plants. In later sections the problems of thermal expansion, materials, and costs will be treated.*

The first step in good design is a complete statement of the conditions to be met. These include initial steam pressure and state, saturated or superheated, maximum and average steam flows needed, and final pressure and temperature required by the process being served. Point at which pressure must be controlled, inlet or outlet and allowable pressure drop must also be known.

Assume that refinery process equipment requires a maximum of 300,000 pounds per hour of steam. Average flow needed is 150,000 pounds per hour. Maximum pressure at line outlet must not exceed 150 psia., saturated. Superheated steam at 450 psia. and 600° F. is available at refinery power plant. Pressure at inlet end will be controlled in the power plant by means of a pressure reducing station. Line inlet pressure will be 180 psia.,

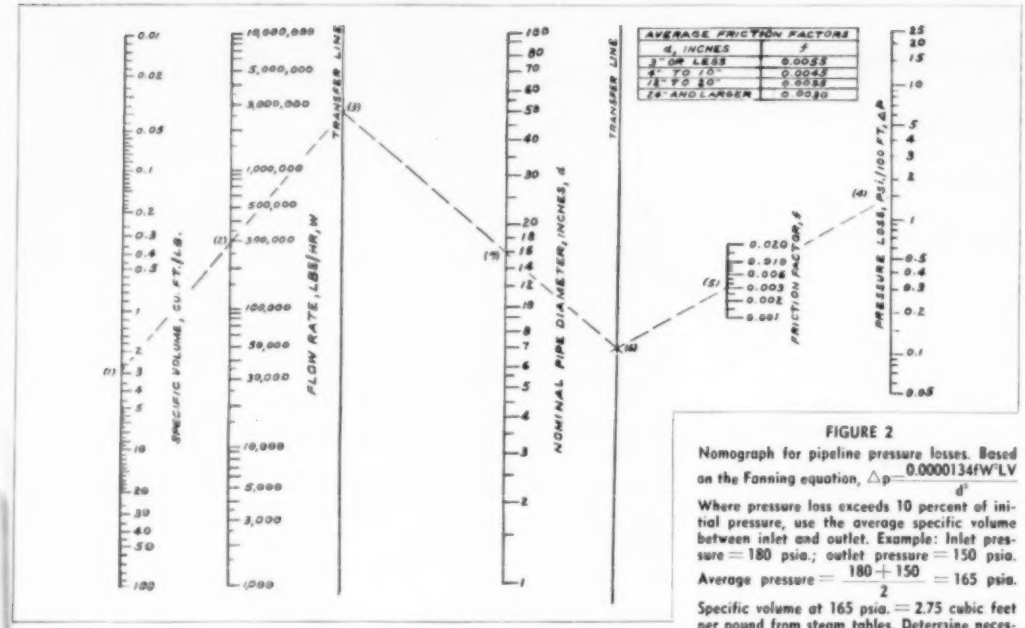


FIGURE 2

Nomograph for pipeline pressure losses. Based on the Fanning equation, $\Delta p = \frac{0.0000134 f W^2 L V}{d^5}$

Where pressure loss exceeds 10 percent of initial pressure, use the average specific volume between inlet and outlet. Example: Inlet pressure = 180 psia.; outlet pressure = 150 psia. Average pressure = $\frac{180+150}{2}$ = 165 psia.

Specific volume at 165 psia. = 2.75 cubic feet per pound from steam tables. Determine necessary pipe diameter for a 1.5 psi. per 100 feet, pressure loss when 300,000 pounds per hour are flowing. (1) 2.75 ft.³/lb.; (2) 300,000 lb./hr.; (3) Transfer line; (4) 1.5 psi./100 ft.; (5) f = 0.0035 from friction factor table on chart, assuming d between 12 and 20 inches; (6) Transfer line; (7) d = 16 inches. When pipe size and flow rate are known beforehand proceed across chart from left to right.

saturated. A 180-150 = 30 psi. pressure is permitted.

This line will be referred to as the nominal pressure loss line because a 30 psi. drop is permissible. To make the problem more nearly typical, a maximum pressure loss line will also be considered.

Assuming the same initial and final steam conditions as above, the only limit on pressure drop is the final pressure and temperature. To eliminate expansion difficulties and reduce line heat losses, it will be assumed that steam temperature is reduced in power plant to 455° F. A ten-pound pressure loss in the desuperheater will also be assumed. Hence, the steam enters line at 440 psia. and 455° F. In overcoming pipe friction, its pressure can fall to about 150 psia. To control flow accurately, a pressure-reducing valve will be installed at line outlet.

During flow through this maximum pressure loss line the steam will become superheated because the pipe acts as an orifice. However, heat losses to the atmosphere and energy needed to produce the higher steam velocities encountered in these lines act to reduce the temperature gain. The final temperature will be assumed to be that corresponding to saturation. Actual value will be checked later when investigating line heat losses.

Distance between power plant and process equipment is about 1700 feet. Terrain permits use of a nearly horizontal run between power plant and process. Line may be pitched wherever necessary for condensate collection.

Nominal pressure loss line must operate with not more than a 30 psi. drop. Using Figure 2 with average line pressure of 165 psia., and 300,000 lb./hr. flow, find the line size as 16 inches diameter for a 1.5 psi. loss per 100 feet, or about 26 psi. pressure

Symbols and Abbreviations

a = Cross-sectional area of pipe, square inches.
A = Cross-sectional area of pipe, square feet.
Btu. = British thermal unit.
C = Line condensate, lbs./hr.
C_w = Line condensate during warm-up, lbs.
dia. = Diameter.
f = Pipeline friction factor.
F. = Fahrenheit degrees.
fps. = Feet per second.
g = Acceleration due to gravity = 32.2 feet per second.
H_s = Enthalpy drop or decrease to accelerate steam, Btu./lb.
hfg. = Enthalpy or heat of vaporization of steam, Btu./lb.
hr. = Hour.
lbs. = Pounds, weight.
lb./hr. = Pounds per hour.
L = Line length, feet.
psi. = Pressure, pounds per square inch.
psia. = Pressure, pounds per square inch, absolute.
psig. = Pressure, pounds per square inch, gage.
p_c = Critical pressure, psia.
p_i = Inlet pressure, psia.
t_i = Initial temperature of steam line, F.
t_2 = Final temperature of steam line, F.
v_c = Critical velocity, feet per second.
v_1 = Initial velocity, feet per second.
v_2 = Final velocity, feet per second.
v_x = Velocity at any point, x, feet per second.
V = Specific volume of steam, cubic feet per pound.
w = Total weight of pipe, lbs. = (length, feet) (weight, lbs./ft.)
W = Steam flow rate, pounds per hour.
Δp = Pressure loss in pipeline, psi.
V_x = Specific volume of steam at any point, x, cubic feet per pound.

drop for 1700 feet. Closer approximation of pressure drop should not be made at this point because there will be additional losses in expansion bends and loops. Table 1 shows that a schedule 40, 0.500-inch wall is suitable for the steam conditions in the line. The line will be assumed welded throughout except for flanged valves.

For the maximum pressure loss line, allowing a 10-psi. drop through terminal pressure regulating valve, the available pressure drop is $440 - 160 = 280$ psi. This is equivalent to a $\frac{280}{1{,}700/100} = 16.5$ psi. loss per 100 feet of pipe. Average line pressure is $\frac{440 + 160}{2} = 300$ psia. Using Figure 2 and a 10 psi. loss per 100 feet (6.5 psi. allowance for bends, etc.), a 10-inch diameter pipe is needed. Table 1 shows that a schedule 40, 0.365 inch wall is suitable for the steam conditions in the line.

Thus, two suitable pipe sizes have been chosen. The final size selected will be governed by relative material, operating, and maintenance costs.

Critical Velocity Study

Experimental and analytical studies have shown that when the pressure loss in a pipe exceeds between about 50 and 58 percent of initial pressure, flow may be limited by the fluid velocity. The limiting velocity which occurs under these conditions is called the critical velocity. Pipeline pressure which coexists with critical velocity is called the critical pressure.

Existence of critical velocity and pressure can be determined mathematically or graphically. For the usual design work, a graphical solution is generally satisfactory and involves less work.

Critical velocity would limit flow if the 10-inch maximum pressure loss line because the terminal pressure of 150 psia. is less than 58 percent of 440 psia., the inlet pressure. To find the critical pressure which coexists with critical velocity, set up the ratio $\frac{W}{a}$. That is: $\frac{W}{a} = \frac{300{,}000}{78.9} = 3800$.

From Figure 3, with $\frac{W}{a} = 3800$, the critical pressure is 27 psig.

Critical velocity would limit flow if the pipeline terminal pressure were equal to or less than 27 psig. Since the terminal pressure of 150 psia. is greater than 27 psig., critical velocity does not limit flow. Hence the 10-inch line will readily transmit 300,000 lbs./hr. In cases where the terminal pressure is less than or nearly equal to the critical pressure found from Figure 3, a check by means of actual computation must be made. This can be made by

$$p_c = 0.01084 \frac{W}{a} - 14.5, \qquad (1)$$

where steam is initially saturated.

If critical pressure is found to exist, the pipe size will usually have to be increased to transmit required flow.

Line heat losses and amount of condensate formed are dependent on several factors. Thickness of insulation, prevailing weather conditions, and steam velocities have the greatest influence on losses. Since practically all refinery steam lines are installed above ground, the outdoor ambient temperature is used in heat loss computations.

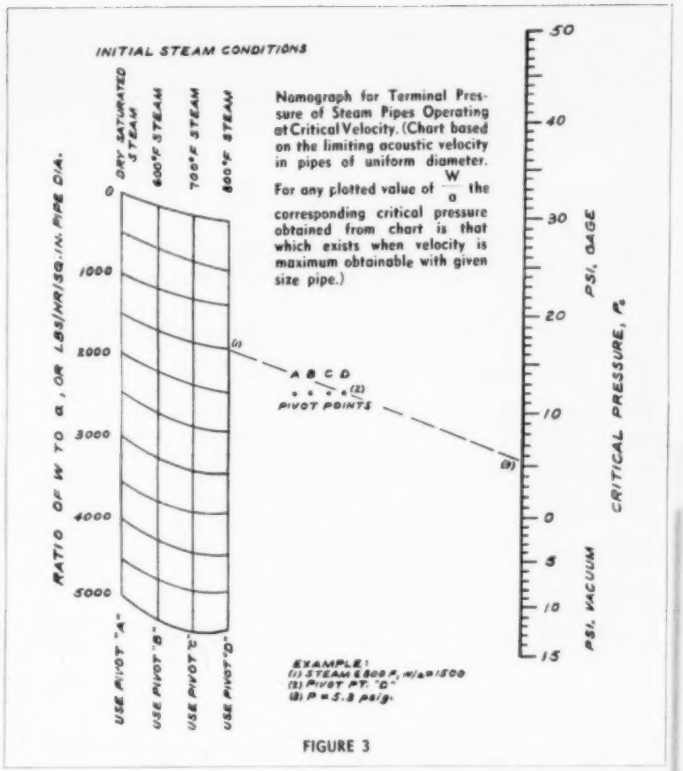


FIGURE 3

Table 1
Pipe wall thickness computation form.

Nominal Pipe Size, Inches	16	10
P = Maximum pressure to which pipe may be subjected, psig.*	455	455
D = Actual outside diameter of pipe, inches	16	10.75
Maximum temperature to which pipe may be subjected, F	600	600
S = Maximum allowable stress, psi., in A53-Grade A seamless carbon steel from Table 3	9,840	9,840
C = Allowance for threading, mechanical strength, and/or corrosion, in inches	0.065	0.065
$t_m = \frac{PD}{2S} + C$ = minimum pipe wall thickness in inches (87½ percent of nominal thickness)	0.419 $t_m / 0.875 = 0.479$	0.303 $t_m / 0.875 = 0.346$
Pipe Schedule number to be used (see a table of pipe properties)	40	40

* Higher steam pressure used in computing wall thickness for both pipes. Use of the higher pressure provides a factor of safety because a pressure reduction takes place before the steam enters transmission line.

Table 2
Heat loss computation form.

Nominal Pipe Size, Inches	16	10
Steam Temperature, F	365	455
Average Air Temperature, F	40	40
Temperature Difference, F	325	415
*Heat Loss, Btu./hr./sq. ft. pipe, F	0.265	0.250
Heat Loss, Btu./hr./sq. ft. pipe	86.1	104
Pipe Surface, sq. ft./linear ft	4.30	2.81
Heat Loss, Btu./hr./linear ft	362	293
Heat Loss, Btu./hr./1700 ft	615,400	498,400
Total Heat Loss, Btu./hr., allowing 25 percent for extra length, elbows, etc.	769,250	620,500
Heat Loss, Btu./lb., for maximum flow of 300,000 lb./hr.	2.56	2.08
Heat Loss, Btu./lb., for average flow of 150,000 lb./hr	5.12	4.16

* Approximate values.

Table 3
Allowable stress values for pipe in steam transmission lines.*

MATERIAL	Specification	Minimum Ultimate Tensile Strength, Psi.	Values of Stress, S, Psi. for Temperatures in °F., not to Exceed							
			150	250	350	400	450	500	550	600
Seamless Carbon Steels	ASTM—A53, A106, API5L									
Grade A		48,000	12000	11520	11040	10800	10560	10320	10080	9840
Grade B		60,000	15000	14400	13800	13400	13200	12900	12600	12300
Electric-Resistance Welded Steel Grade A	ASTM—A135, API5L	48,000	10200	9800	9400	9150	8950	8800	8550	8350
Grade B		60,000	12750	12250	11700	11500	11200	11000	10700	10450
Lap-Welded Steel	ASTM—A53, A106, API5L	45,000	9400	9000	8550	8350	8150	7950	7750	7550
Butt-Welded Steel	ASTM—A120		6500	6250	6000	5800	5700	.....	.....	.....

* From American Standards Association Code for Pressure Piping.

Assuming two inches of 85 percent magnesia insulation with a layer of weatherproofing material, heat losses are computed as shown in Table 2.

Acceleration of steam in the line results from a drop in heat content or enthalpy. The heat required to accelerate the steam can be found from,

$$H_a = \frac{v_2^2 - v_1^2}{2g(778)} \qquad (2)$$

The velocity at any point can be found from the continuity equation,

$$v_x = \frac{WV_x}{3600\ A_x} \qquad (3)$$

For the 16-inch nominal pressure loss line with a flow of 300,000 lbs./hr. at 180 psia. entering and 150 psia. leaving,

$$v_1 = \frac{300{,}000\ (2.53)}{3600\ (1.23)} = 172 \text{ fps.}$$

$$v_2 = \frac{300{,}000\ (3.02)}{3600\ (1.23)} = 204.5, \text{ say } 205 \text{ fps.}$$

and

$$H_a = \frac{(205)^2 - (172)^2}{64.4\ (778)} = 0.25 \text{ Btu./lb.}$$

By a similar calculation, $H_a = 3.7$ Btu./lb., for the 10-inch line, when leaving steam is assumed to be 150 psia., saturated.

Enthalpy of the 180 psia. saturated steam entering the 16-inch line is 1196.9 Btu./lb. Heat loss during 300,000 lb./hr. flow is 2.56 Btu./lb. An enthalpy drop of 0.25 Btu./lb. accelerates the steam. Hence, calculated leaving enthalpy = 1196.9 — (2.56 + 0.25) = 1194.09 Btu./lb.

Enthalpy of leaving steam at 150 psia. saturated is 1194.1 Btu. lb. Hence, to have 150 psia. saturated steam leave the line (1194.10 — 1194.09), or 0.01 Btu./lb. must be supplied by the steam. This heat will be obtained from the latent heat of vaporization given off by condensation of some of the steam in the line. Since heat can be obtained from this source at all times during steam flow, required temperature, and pressure conditions will be obtained at outlet.

Line condensation during maximum steam flow can be computed from,

$$C = \frac{W(\text{leaving enthalpy} - \text{calculated leaving enthalpy})}{\text{enthalpy of vaporization at leaving pressure}} \qquad (4)$$

For the 16 inch line with 300,000 lbs./hr. flowing,

$$C_w = \frac{300{,}000\ (0.01)}{863.6} = 3.5 \text{ lb./hr.}$$

Condensation during average flow conditions of 150,000 lb./hr. is found by means of the same relation. Enthalpy drop to accelerate the steam is neglected for average flows in normal pressure loss lines because the value is usually small. For 150,000-lb. flow, calculated enthalpy of leaving steam = 1196.90 — 5.12 = 1191.78 Btu./lb. Hence,

$$C = \frac{150{,}000\ (1194.10 - 1191.78)}{863.6}$$

= 405 lb./hr.

Greatest condensation occurs during line warm-up. Hence, condensate removal equipment must be sized on warm-up basis, not average steam flow basis. Of the many methods used for determination of condensate quantities during warm-up, the simplest is based on the specific heat of the materials involved. To account for radiation and insulation, a 25 percent factor of safety is usually used. Hence,

$$C_w = \frac{1.25w\ (t_2 - t_1)(0.12)}{\text{hfg at inlet conditions}} \qquad (5)$$

For the 16-inch line using schedule 40 pipe which weighs 83 pounds per foot,

$$C_w = \frac{1.25\ [(83)(1{,}700)]\ (373\text{-}40)(0.12)}{850.8} = 8275$$

Hence, total condensate removal capacity should be about 9000 pounds divided by the allowable warm-up period in hours.

A group of similar calculations must now be made for the 10-inch maximum pressure loss line. Enthalpy of the 440 psia., 455° F. steam entering the line is 1205.4 Btu./lb. Heat loss during 300,000 lb./hr. flow is 2.08 Btu./hr. An enthalpy drop of 3.7 Btu./lb. accelerates the steam. Hence, calculated leaving enthalpy = 1205.4 — (2.08 + 3.7) = 1199.62 Btu./lb.

Enthalpy of leaving steam at 150 psia. saturated is 1194.1 Btu./lb. Therefore, under maximum flow conditions the steam will be superheated from entering to leaving point. Enthalpy difference of (1199.62—1194.1) = 5.52 Btu./lb. will produce the superheat. Because the steam is superheated throughout the line, condensation will not occur during maximum flow conditions.

For most refinery applications the steam leaving the line may be taken as saturated at the desired pressure. Where precise temperature values are required, some form of control usually must be used at the end of long lines.

During average flow conditions, 150,000 lb./hr., line heat losses are 4.16 Btu./lb. Enthalpy drop to accelerate the steam is 0.925 Btu./lb. Hence, calculated leaving enthalpy is, (1205.40 — 5.09) = 1200.31 Btu./lb. As in the case of maximum flow, the steam is superheated throughout the line.

Of course, during warm up of the 10-inch line, condensate will be formed. A small amount will also form during periods of extremely small loads on the line. In either case the amount of condensate to be handled is computed from the relations given above in the discussion of the 16-inch line.

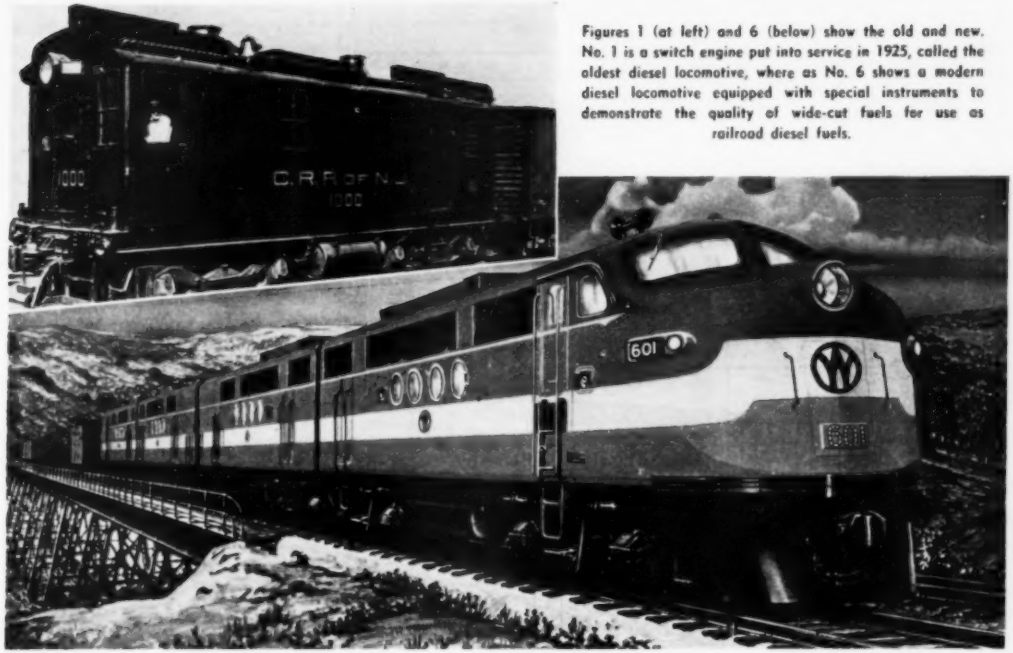
Thus, condensation during warm-up of the 10-inch line is

$$C_w = \frac{1.25\ [(40.5)(1700)]\ (455 - 40)(0.12)}{770} = 5560 \text{ lbs.}$$

Condensate collection and removal equipment suitable for handling about 6000 pounds divided by the allowable time is therefore necessary. In general, it will be found that equipment sized on warm-up basis is also suitable for average flow basis. However, both quantities should be checked.

Extensive experience with steam transmission lines has shown that the design methods presented in this article are best for the usual refinery problem. Pipeline expansion problems will be discussed in Part II of this article.

End of Part I. Part II will appear in an early number.



Figures 1 (at left) and 6 (below) show the old and new. No. 1 is a switch engine put into service in 1925, called the oldest diesel locomotive, where as No. 6 shows a modern diesel locomotive equipped with special instruments to demonstrate the quality of wide-cut fuels for use as railroad diesel fuels.

Wide-Cut Diesel Fuels Safe For Railroad Locomotives

A. B. CRAMPTON, S. H. HULSE and N. H. RICKLES
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WORLD WAR II provided a tremendous impetus to the production of diesel engines. After producing but 15 million horsepower during its entire first 40 years, the United States diesel industry produced 36 million horsepower, mainly for the military, in the single year of 1944. Although the return to peacetime conditions caused a considerable drop in production in 1946, recovery started in 1947, and estimated production for 1948 is in excess of 20 million horsepower.

This rapid growth of the diesel industry raises a question regarding availability of sufficient diesel fuel of adequate quality. Some of the factors looking toward a satisfactory solution to this problem are discussed here. The use of a "wide-cutting" technique for the preparation of diesel fuels is presented as a method of providing greater flexibility in the production of increased volumes of diesel fuels of unimpaired quality characteristics. While the railroad problem will be dealt with specifically, the general conclusions apply equally well to the entire diesel picture.

This presentation was before the recent annual meeting in Detroit of the Society of Automotive Engineers.

RAILROAD diesels, of American manufacture, were introduced in this country in 1925 when the first diesel electric switcher (see the accompanying Figure 1) was put into operation. Diesels soon proved their value in switching work and today there are over 3100 of these locomotives in operation. The advantages of the diesel locomotive for railroad passenger service, which were first illustrated by the outstanding performance of the Burlington "Zephyr" in 1934, are now well established. Although only in service since 1940, the diesel freight locomotive is showing comparable advantages. In June, 1948, there were about 630 diesel passenger locomotives, 920 freight locomotives, and 60 or 70 locomotives classed as either passenger or freight. The diesel trend, is illustrated by Figure 2, which shows the percentage of diesel locomotives on order during the period from 1932-48, and indicates that this figure has grown from 20 to 50 percent in the early thirties to more than 90 percent in recent years.

As the number of diesel locomotives has increased the demand for diesel fuels has increased rapidly and in 1948 the consumption rate averaged about 80,000 barrels (42's) per day. It has been estimated that the railroad diesel

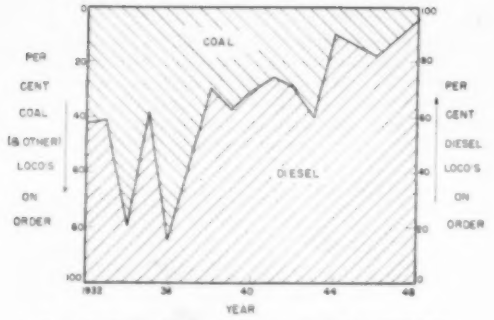


Figure 2—Types of Railroad Locomotives on Order 1932-1948

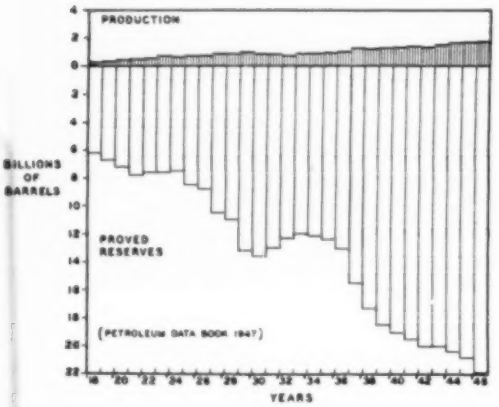


Figure 3—U.S. Crude Petroleum Production Compared with Proved Reserves.

TABLE 1

	1945[a] 1000's Btu. Loco Hr.[b]	1948[a] 1000's Btu./Loco. Hr.[b]
Switch Engines:		
Coal fired steam	10,680	10,510
Oil fired steam	8,220	7,820
Diesel	775	792
Ratio coal to diesel	(13.8)	(13.3)
Freight Engines	**Btu./Ton Mile**	**Btu./Ton Mile**
Coal fired steam	1,540	1,440
Oil fired steam	1,260	1,070
Diesel	221	208
Ratio coal to diesel	(7.0)	(6.9)
Passenger Engines	**1000's Btu. Car Mile**	**1000's Btu. Car Mile**
Coal fired steam	216	275
Oil fired steam	130	181
Diesel	35	35
Ratio coal to diesel	(6.2)	(7.9)

[a] Based on I.C.C. Bulletin M230 for first eight months of each year.
[b] Lower (net) heating values used are:

Coal	12,710 Btu. per pound;
Fuel oil	139,500 Btu. per gallon;
Diesel fuel	130,200 Btu. per gallon.

TABLE 2

U. S. domestic demand—Crude & products
(Thousands of Barrels Daily)

	1938	1944	1946	1947	Ten Year Increase
Gasoline	1433	1728	2013	2178	745
Kerosine	154	196	244	281	127
Diesel	**58**	**192**	**148**	**200**	**142**
Other Distillate	264	380	517	617	353
Residual	800	1390	1307	1420	620
Other	406	671	678	753	347
Total	3115	4566	4907	5449	2334

engine production rate in this country will probably exceed 3 million rated horsepower per year over the next five years and that this will result in an increase of the order of 20,000 to 25,000 barrels daily in the demand for railroad diesel fuels every year during this period. By 1953 U. S. railroads likely will be using about 200,000 B/D of diesel fuel. It is also estimated, on the basis of the 1945 and 1947 figures for haulage, that if all railroad duties were taken over by diesels the total consumption of diesel fuel would be in the neighborhood of 300,000 B/D. This estimation constitutes a major extrapolation and time alone will tell whether it is high or low.

On the basis of these calculations, the present 270,000 barrels per day of fuel oil consumed in oil-fired steam locomotives about equals the volume of diesel fuel required to power all the railroads if completely converted to diesel.

One of the major reasons for the shift to diesel engines has, of course, been the matter of fuel economy. On the basis of Interstate Commerce Commission figures for 1945 and 1948 (U. S. Class I Railroads), a relative "operating thermal efficiency" has been calculated for coal, fuel oil, and diesel fuel powered locomotives. (See Table 1.)

In addition to fuel economy, other reasons variously mentioned for the switch to diesel electric locomotives are smoke abatement, less wear and tear on tracks, better service factor (locomotive availability), ability to handle a wide variety of assignments, economy in servicing facilities, maximum use of investment, conservation of manpower, high continuous speeds, and fewer stops required for fuel, water and cleaning.

To the supplier of petroleum products, the outstanding feature of this picture is the increase in fuel requirements which is indicated and the question of how this demand may be met. The amount of crude oil available is a logical starting point for a discussion of this situation.

Supply and Demand Picture

Figure 3 shows the crude oil production in the United States and the proved reserves in the U. S. versus the years of 1918 to 1946. It will be noted that the billions of barrels of proved reserves year by year have been continually growing larger. As of 1946 the proved reserves are about a dozen times greater than the annual production rate. Production and consumption are expected to go up as the years go by. New reserves also will be found but the ratio of new reserves to future consumption is not predictable. Considering the help that can be expected from crude imports, it is clear that the country is not faced with an immediate shortage of oil—certainly not so immediate that something cannot be done about supplies of liquid fuels by the eventual application of already proven synthetic methods. Coal reserves alone are estimated sufficient, if converted to oil, to supply oil for over 1,000 years at the present rate of consumption. In addition to coal, there are large reserves of other carbonaceous raw materials such as shale, natural gas and tar sands.

As to the oil products competing with diesel fuel for the crude, Table 2 shows the demand over the ten-year period 1938-1947 in the U. S. Total crude oil requirement increased about 75 percent, whereas diesel fuel requirement has increased about 250 percent.

Also, the other major "middle of the barrel" products increased at a faster rate than total demands. Kerosine, for example, increased over 80 percent and other distillate fuels more than 130 percent.

The petroleum industry passed through a critical supply problem during 1947 and the first part of 1948, due to the unprecedented demand. By late 1948 this situation had substantially improved. The latest estimates for the whole year show a gain in total demand of about 5.5 percent over the record 1947 level, while the total supply was estimated to be about 8.9 percent greater than in 1947. The realization of these supply and demand estimates allowed for a stock build-up of about 180,000 B/D and would indicate some easing in the U. S. situation unless unforeseen military requirements develop. In any event, the balance between supply and demand is a fine one and may continue to be for the next two or three years.

The railroad diesel fuel demand has increased even more rapidly than the other petroleum products during the last ten years. This will taper off eventually as the railroads approach diesel saturation, calculated at about 300,000 B/D, namely, about 5 or 6 percent of present day crude runs. While this is relatively small based on the total of petroleum products there tends to be a problem in connection with supply because:

1) Very often high quality diesel fuels are used where other, less restrictive fuels would suffice.

2) The quality of diesel fuel being demanded exceeds, in spot situations, is to avoid the diversion of high qual- that easily obtainable from the crude available. Relaxation of specifications or added processing equipment might be necessary to produce the volume required.

3) This type of product competes with distillate fuels which also show an abnormal increase in demand, particularly kerosine, heating oils, and diesel fuels for other applications than railroads.

Accordingly, every barrel of high grade diesel fuel which can be saved is important and one means of saving ity diesel fuels to heating purposes where low octane distillate and other less critical fuels will do just as well. The heating load of diesel-powered passenger trains in the winter and the air conditioning load in summer are large proportions of the fuel requirements. Yet diesel fuel is used for these purposes rather than coal or other petroleum products. Such diversion practices might be looked into to see whether they are really justified on a cost basis.

In most petroleum supply problems there are two factors that are in-

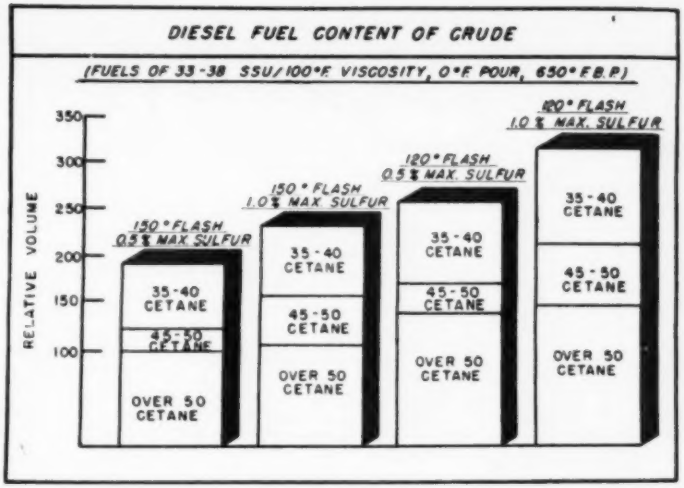


Figure 4

TABLE 3

Specifications of diesel locomotive fuel

INSPECTION	ENGINE MANUFACTURERS (Average of 5)		RAILROADS (Average of 14)	
	Spread	Average	Spread	Average
Viscosity @ 100 °F., SSU:				
Minimum	33–38	35	32–38	35
Maximum	50–100	67	45–70	52
Flash Point, °F.		150		150
Cetane No., Minimum	45–48	45	35–50	48
Sulfur, Wt.%, Maximum	0.5–2.0	0.85	0.10–1.50	0.50
Distillation, °F.:				
90% Point, Max.	625–690	665	540–675	632
End Point, Max.	675–700	690	650–700	675

TABLE 4

Diesel fuel inspection data

INSPECTION	Conventional Fuel	WIDE-CUT FUELS		
		High C.N. Low S	Low C.N. Low S	Low C.N. High S
Viscosity @ 100 °F., SSU	35	35	35.5	35.5
Pensky-Martens Flash Point, °F.*	165	130	130	130
Cetane No.	50	50	45	45
Sulfur, Wt. %	<0.5	<0.5	<0.5	<1.0
Distillation, °F.:				
Initial Point	350	310	310	310
50% Point	510	510	510	510
90% Point	585	600	600	600
End Point	650	650	650	650

* Normally about 5° F. higher than Tag Closed Cup Flash point on a given fuel.

TABLE 5

Diesel fuels used in test—Typical inspection data

INSPECTION	Conventional Fuel	Wide-Cut Fuel High C.N., Low S
Viscosity @ 100 °F., SSU	35	33
Pensky-Martens Flash Point, °F.	150	130
Cetane No.	50	50
Sulfur, Wt. %	<0.5	<0.5
Distillation, °F.		
Initial Point	350	310
50% Point	510	490
90% Point	585	600
End Point	650	650
Heating Value		
Low, Btu./Gallon	128,800	127,500

TABLE 6

Engine condition for typical locomotive using wide-cut diesel fuel

[Final inspection of test control cylinder assemblies (Cyl. No. 8-B & 15-B)]

PART	Condition
Compression Rings	Free, good condition.
Oil Rings	Normal deposits
Piston, top land	Normal deposits.
Piston varnish	Normal, medium-light deposits
Combustion chamber and exhaust ports	Light, sooty deposit
Valve stems	Oily, sooty deposit; no varnish
Liner Surfaces	Excellent condition

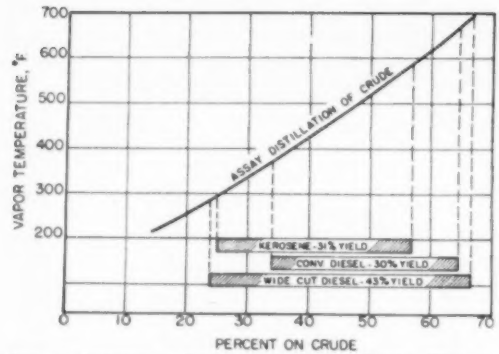

VAPOR TEMPERATURE, °F
ASSAY DISTILLATION OF CRUDE
KEROSENE - 31% YIELD
CONV. DIESEL - 30% YIELD
WIDE CUT DIESEL - 43% YIELD
PERCENT ON CRUDE

Figure 5—Production of Kerosine or Diesel Fuel Showing Effect of Wide Cutting.

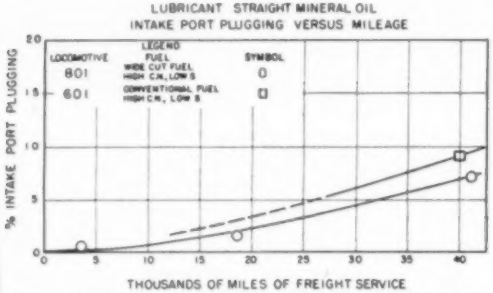


Figure 7—Performance of High-Speed Diesel Fuels in Electro-Motive F.T. Diesel Engines in Freight Service, New York, Ontario & Western Railway.

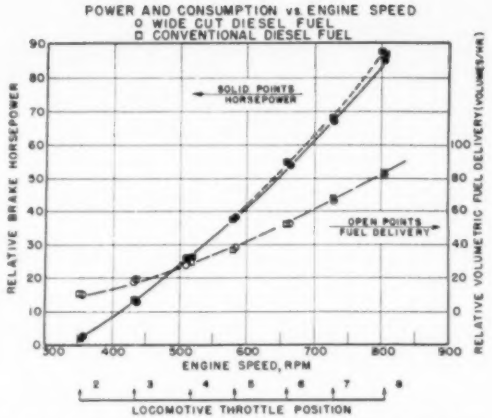


Figure 8—Performance of High-Speed Diesel Fuels in an Electro-Motive F.T. Diesel Engine Static Test—New York, Ontario & Western Railway. Power and Consumption vs. Engine Speed.

TABLE 7

Power output comparison

Throttle position	8	7	6	5	4*
Engine speed, rpm.	800	725	650	575	500
Relative Engine Brake Horsepower:					
Conventional fuel	86.4	69.1	52.4	36.8	22.1
Wide-cut fuel	84.8	67.9	51.2	35.9	21.1
Power Loss with Wide-Cut Fuel, %					
Avg. power loss for 8 throttle positions, percent	1.1				

* No differences in power noted at throttle positions 4, 3, 2 and 1.

terdependent. They are quality and volume. The less restrictive the quality the easier it is to attain a given volume. On the assumption that consumers do not desire to limit their chances of obtaining their requirements by unnecessary quality specifications, fuel studies have been made to find out which properties are really important in performance, so that no unnecessary limitations will be placed on volume availability for railroad use.

A recent compilation of users' specifications for railroad diesel fuels is shown in Table 3. Note:

1) Flash point appears to be limited at 150° F. Probably 120° F. would be characteristic of kerosine, and kerosine or blends thereof have been used satisfactorily in bus and truck diesels. In fact, it has been reported that two or three railroads have been using kerosine-type fuels for some time.

2) Cetane number requirements seem to average about 45; though some purchasers demand 50. It is felt that these qualities might not be necessary to the satisfactory performance of the engine for which they are specified.

3) Sulfur content varies from 0.5 to 2.0 percent. This lower limit may not really be needed when specified.

An illustration of what one refiner could do to extend supplies of railroad diesel fuels from his pool of crude oil stocks is shown in Figure 4. Starting with a specification base of 50 minimum cetane number, 0.5 percent maximum sulfur and 150° F. minimum flash, the following could be done at the expense of other products:

1) 45 percent increase of 50 cetane number provided the flash could go to 120° F. and the sulfur to 1.0 percent.

2) 80 percent increase of 150° F. flash and 0.5 percent sulfur if the cetane number could be dropped to 35.

3) 130 percent increase of 150° F. flash if the sulfur could go to 1.0 percent and the cetane number to 35.

4) 220 percent increase if the flash could go to 120°, the sulfur to 1.0 percent and the cetane number to 35.

For refineries having an assortment of crudes permitting blending to cetane and sulfur limits, the relaxations in these limits would not have to be so great to accomplish the indicated increase in supplies. We do not at present know how many of these relaxations can be tolerated and still get economical engine performance, but we are on the way toward finding out. An illustration of fuels that might result from such relaxations is shown in Table 4.

The series involves a group of 130° F.-flash fuels since by this route, called "wide-cutting," it is possible to extend supplies with the least degradation in cetane number and sulfur content. The advantages of this method are based on the interdependence of supplies of kerosine and high quality diesel fuels. Both generally come from the same type of crude but maximum yields of both cannot be produced by the refiner from the same center fraction. When producing diesel fuel there are also produced light kerosine fractions not marketable as such and when producing kerosine there are heavy diesel fuel fractions which also present a problem. This fact is illustrated by Figure 5 which shows a schematic volatility comparison of a typical kerosine, a conventional diesel fuel, and a wide-cut diesel fuel. In effect, the kerosine is the coat and vest, the present diesel fuel the vest and pants. The wide-cut, 130° F.-flash fuel is the coat, vest and pants and results in larger coverage for diesel fuel supplies, by utilizing the light and heavy fractions that are not readily usable in conventional fuels. Its adoption would have the effect of

increasing the flexibility of refinery operations, and would permit unusually high yields of diesel fuel when required. An equivalent increase does not result from mixing kerosine and diesel fuel in the field—the operation must be carried out in the refinery during the actual distillation process.

If the limit in cetane number has not been reached after testing these fuels, lower cetane fuels will be tested and these data will be discussed with the engine manufacturers and the railroad people, for only by cooperation can generally acceptable compromises be arrived at for the mutual benefit of the petroleum and railroad people.

Trends toward the utilization of the diesel in railroad operation were quite evident prewar and this company was then contemplating a considerable amount of experimental work to determine the fuel and lubricant requirements. The war, however, delayed this effort but in 1945 arrangements were made with New York, Ontario and Western Railway and with the Electro-Motive Division of General Motors Corporation to carry out the field tests necessary to establish the validity and significance of laboratory studies.

Field and Laboratory Tests

While laboratory data on smaller engines had shown the practicality of certain variations in diesel fuel characteristics, firm data were not available to indicate the effect of these factors on the performance of the large engines of a diesel locomotive. Only such tests on full-scale equipment under representative operating conditions could prove the adequacy of a given product.

The test locomotives used were 2700 horsepower, electro-motive F. T. diesels composed of 2, 2-cycle, 16-cylinder ($8\frac{1}{2}$-inch bore x 10-inch stroke) engines. These locomotives were used in regular freight service and averaged one round trip per day of 240 miles with loads varying from 1000 to 2000 tons. One locomotive, Figure 6, was equipped with special recording instruments to measure continuously the pertinent operating variables.

About 15 months of operation on the O. & W. Railway have now been completed during which period three locomotives have been fueled entirely on a wide-cut diesel fuel so that the performance of this fuel might be compared with that of the conventional diesel fuel. Typical inspections of the test fuels are given in Table 5.

The lower heating value shown in this case is not necessarily typical of wide-cut fuels. By adjusting volatility limits, and particularly if lower cetane numbers were permitted, a higher heat-

TABLE 8

Fuel consumption comparison—Volumetric basis

Throttle position	8	7	6	5	4*
Engine speed, rpm.	800	725	650	575	500
Relative Volumes per bhp.-Hr.					
Conventional fuel	81.8	80.4	79.9	82.1	85.5
Wide-cut fuel	83.6	81.1	80.6	83.1	87.5
Increase in Consumption with the Wide-Cut Fuel, Percent	2.2	0.9	0.9	1.2	2.3
Avg* for 8 throttle positions, percent	1.9				

* Weighted for volumes per hour of fuel consumed in each of the 8 throttle positions and assuming equal operating time in each position.

TABLE 9

Relation of fuel economy to heating value, wide-cut diesel fuel compared to conventional diesel fuels in high speed automotive engines (dynamometer data)

(Relative fuel economy and heating value of conventional fuels = 100)

ENGINE	Type	WIDE-CUT DIESEL FUEL	
		Relative Volumetric Fuel Economy	Relative Volumetric Net Heating Value
General Motors 1-71	2-cycle, direct injection	98.8	98.7
Mack-Lanova END-672	4-cycle, energy cell combustion chamber	98.9	98.9
Leyland 7.4 litre	4-cycle, direct injection	98.6	98.6
Thornycroft 4.0 litre	4-cycle, indirect	98.5	98.6

TABLE 10

Relative exhaust smoke densities

(Comparison of wide-cut diesel fuel with conventional diesel fuels)

FUEL	EQUAL LOADS—RPM					
	Near Full Load			Full Load		
	1000	1400	1800	1000	1400	1800
Engine A						
Wide-cut	100	79	77	100	79	77
Conventional	100	91	89	100	91	91
Engine B						
Wide-cut	67	80	97	60	73	83
Conventional	67	80	97	63	83	100

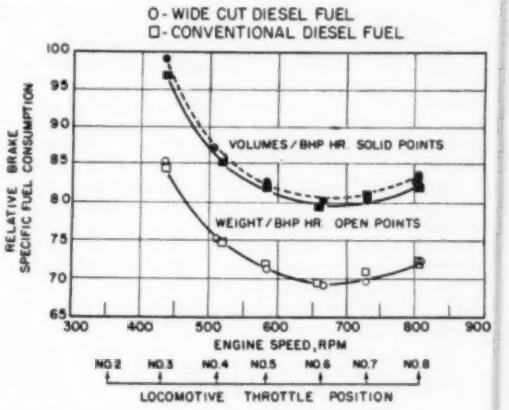


Figure 9—Performance of High-Speed Diesel Fuels in an Electro-Motive F.T. Diesel Engine. Static Test—New York, Ontario & Western Railway. Fuel Consumption vs. Engine Speed.

TABLE 11

Maximum equilibrium fuel temperatures Electro-motive locomotives

	Electro-Motive Data F-3 Locomotives			O. & W. Data F-T Locomotive
Ambient temp., °F.	88	95	100	95
Maximum fuel Tank temp., °F.	114	115	117	118

TABLE 12

Minimum fuel flash point for safe refueling of diesel locomotives

	Maximum Observed Temp.	Estimated Max. Fuel Temp. for E.M.D. Loco.	Max. Safe Fuel Temp. For 130° F. Flash Fuel
Ambient temp., °F.	95	125	.....
Maximum fuel tank temp., °F.	118	130	143
Minimum safe fuel flash point, °F. (Pensky-Martens)	107	119	130

ing value could have been obtained.

As will be seen, the wide-cut fuel has proven to be equivalent to the conventional fuel in all performance aspects.

A. Effect of Wide-Cut Fuel on Engine Conditions—

Careful and detailed records of parts replacement requirements and of the maintenance work needed, during the period of over a year, have shown that the outstanding performance of these diesel engines in this regard has not been adversely affected by operation on the wide-cut diesel fuel.

Inspections of the test engines have indicated the wide-cut fuel is equivalent to the conventional fuel with respect to deposit forming tendencies, both fuels forming very moderate deposits. This is illustrated by the extent of air-intake port plugging which has been observed with these fuels. (Figure 7.) The deposit level in the intake ports was very low for both fuels and the wide-cut fuel (ports 7 percent plugged) was at least equivalent to the conventional fuel (ports 9 percent plugged) after 40,000 miles of operation. It should be emphasized that these diesel engines are so designed that the engine performance is not adversely affected until at least 50 percent of the port area is blocked.

An example of the deposits found after extended operation on the wide-cut fuel is given in Table 6 which shows the results of an inspection of a typical locomotive after 72,000 miles of operation on this fuel and more than 100,000 miles of operation on the crankcase lubricant.

Thus the service test has demonstrated the wide-cut fuel to be equivalent to the conventional fuel as regards its effect on engine condition.

B. Effect of Wide-Cut Fuel on Exhaust Smoke Density—

The smoking characteristics of diesel engines and fuels are, of course, of great interest in practical applications since more and more communities are insisting upon satisfactory performance in this respect. However, neither our own observers, nor the railroad personnel, have been able to detect any appreciable smoke when operating these electro-motive engines on either of the two fuels in question.

C. Effect of Wide-Cut Fuel Characteristics on Power Output and Fuel Consumption—

In order to obtain an accurate picture of the relative consumption of the wide-cut and conventional diesel fuels in railroad equipment a static test was carried out at the diesel shop of the New York, Ontario and Western Railway with assistance from the railroad people and the Electro-Motive Division of General Motors. This test was carried out on one of the locomotives, which had been in operation for eleven months on the wide-cut fuel, by absorbing the power output of the generator as heat and measuring the power in terms of electrical units. In contrast with the normal constant speed (with an infinite number of speeds to choose from) and infinitely variable load type of automotive diesel operation, the locomotive operator has a choice of only eight throttle positions. These throttle positions represent equal increments of diesel engine speed, together with pre-established loads (fuel rack settings) for each speed. This results in a nearly straight line power vs. speed curve and also means that the static test conditions can easily duplicate actual service operating conditions.

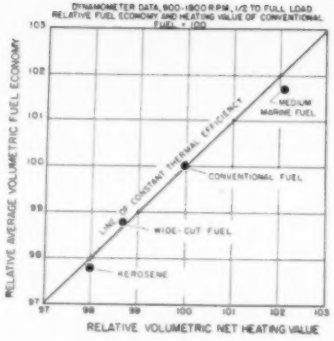


Figure 10—Fuel Economy of Wide-Cut Diesel Fuel Compared with Other Conventional Diesel Fuels in General Motors 1-71 Engine.

This static test indicated that, over the speed and load range, the wide-cut fuel gave about 1 percent less power than the conventional fuel and that about 2 percent more of the wide-cut fuel was consumed (volumetric basis) per horsepower hour. These differences are in general agreement with the volumetric net heat contents which show this particular experimental wide-cut fuel to be 1.4 percent lower than the conventional fuel in this respect.

(1). Power Output—A comparison of the power output obtained at the various throttle positions is shown in Figure 8. Somewhat less power was obtained at the higher speeds with the wide-cut fuel as illustrated in the summary Table 7 read from Figure 8.

If the power differences are averaged on the basis of equal operating time in each throttle position a value of 1.1 percent is obtained for this particular test fuel as the average power loss.

(2). Fuel Consumption—Volumetric fuel consumption data (Figure 8) indicate that the same quantity of each fuel was injected at any given engine speed. Figure 9 shows the specific fuel consumption data. When considered on a gravimetric basis, both fuels were alike, the same weight of fuel being required to produce a brake horsepower hour in each case. On a volumetric basis, as shown in Figure 9 and Table 8 read from the figure, a 1.9 percent higher consumption was indicated for this wide-cut fuel.

D. Laboratory Studies in Automotive High Speed Engines—

Inasmuch as the fuel modifications considered for the diesel locomotive might also find application in the automotive or related fields, the performance characteristics of the wide-cut fuel were compared with those of the conventional fuel on four automotive type engines on laboratory dynamometer test stands. These laboratory tests, which were conducted under closely controlled conditions, provided greater accuracy as regards the measurement of power output and fuel consumption than was possible in field service tests. They were carried out in a General Motors 71-cubic-inch engine and a Mack-Lanova 672-cubic-inch engine, and in two engines of British manufacture; a Leyland 7.4-litre engine and a Thornycroft 4.0-litre engine.

(1). Fuel Economy Comparisons—The fuel economy of the wide-cut fuel has been compared with a wide range of diesel fuels extending from kerosine to a relatively heavy diesel fuel in a General Motors 71-cubic-inch engine. As may be seen from Figure 10, fuel economy was found to be proportional to the net heating value of the fuel, and the engine was found to operate at substantially constant thermal efficiency over the range of fuels tested. It will be seen that the wide-cut fuel behaved normally in this respect. Similarly, in all of the laboratory engines, which represent a variety of automotive high-speed diesel engine designs, the difference in fuel economy between wide-cut and conventional fuels was proportional to the difference in net heating value as is shown in the summary Table 9.

From these data it may be concluded that on the average these engines operate at constant thermal efficiency on either fuel and that economy is dependent only on the heat content of the fuel.

(2). Effect of Fuel Properties on Output—A loss of 1 to 3 percent in power was obtained with the wide-cut diesel fuel in comparison with conventional diesel fuel in the laboratory engines. This loss is due to the lower heating value and also the lower viscosity which results in less fuel de-

livered per pump stroke, at a given rack setting, on the smaller automotive type engines.

(3). Effect of Fuel Properties on Exhaust Smoke Density—The wide-cut diesel fuel was found to produce the same, or lower, exhaust smoke densities than the conventional diesel fuels as shown in the summary Table 10 which presents data obtained in two engines of widely different design characteristics.

E. Safety Aspects of Wide-Cut Diesel Fuel—

The flash point of a fuel is generally accepted as an indication of the fire hazard involved in its storage and handling, and therefore, most automotive and railroad engine manufacturers have established minimum flash point specifications for fuels to be used in their engines. In the automotive field, the use of kerosine-type fuels with flash points of 120° F., or lower, has firmly established this flash point level as entirely safe. On the other hand, 150° F.-flash fuels are normally specified and are in general use in diesel locomotives throughout the railroad industry, even though the potential hazard from the use of a lower flash fuel in railroad service would not appear to be any more serious than in automotive service. Since a survey had indicated that federal and state statutes would not prohibit the use of a 130° F.-flash point fuel, and indeed that two or three railroads were using 120° F.-flash fuels, there appeared to be no valid objection to its adoption for railroad service.

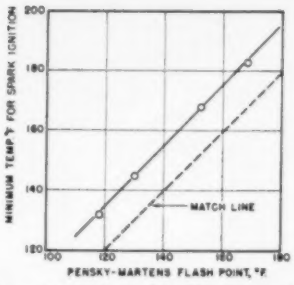


Figure 11—Minimum Fuel Temperature for Spark Ignition of Vent Gas.

In order to obtain more reliable information in the necessity for the present restrictive specifications, the safety aspects involved in the storage and handling of wide-cut diesel fuel have been studied in a simulated electro-motive locomotive fuel system to determine the hazards involved in the use of a lower flash fuel. Since the greatest fire hazard would exist when fuel vapors were being displaced through the fuel tank vent during a refueling operation the laboratory studies were primarily concerned with this situation. This work showed the Pensky-Martens closed cup flash point of the fuel to be the most reliable criterion of inflammability and, as may be seen from the results presented in Figure 11, a good correlation exists between the P-M flash point, °F., and the minimum fuel temperature for spark ignition of the vent gas. Explosions in the fuel tank vapor space are effectively prevented by the use of flame arrestors in the tank vent line and therefore may be disregarded.

The service data available indicate that 120° F. is the maximum fuel temperature to be expected, when the ambient temperature is in the range of 100° F., as may be seen from Table 11 which presents typical data obtained on the N. Y., O. & W. Railroad as well as data furnished by the Electro-Motive people.

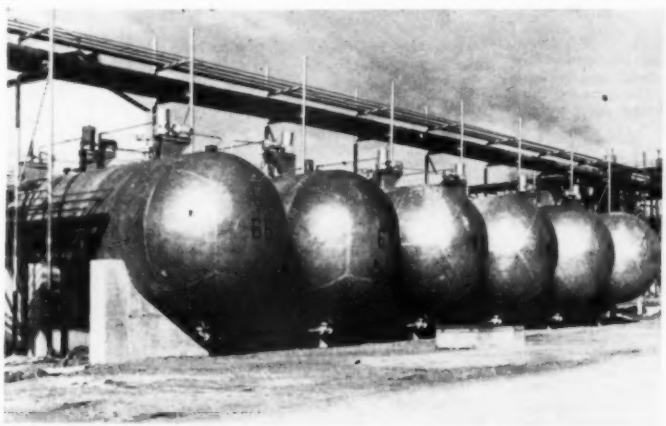
The data in Table 11 together with data read from Figure 11, make it possible to estimate the minimum fuel flash point required for safe refueling operations as shown by Table 12.

At 125° F., the most critical ambient temperature likely to be encountered, the estimated maximum fuel tank temperature is 130° F. which would allow safe operation with a fuel of 119° F.-flash point. The wide-cut fuel, with a flash point of 130° F. would be safe at a fuel tank temperature up to 143° F. The fuel tank temperatures reached in service could, of course, be reduced considerably by the introduction of a cooler in the injector return line.

Conclusion

It is felt that these data, together with the record of 15 months of trouble-free service on the New York, Ontario and Western Railway, furnish clear-cut evidence that the wide-cut, 130° F.-flash point fuel is entirely safe for railroad diesel engine service.

Large Pressure Vessels Fabricated Out of Aluminum



This battery of aluminum storage tanks in use at the chemical plant of Lion Oil Company at El Dorado, Ark., are understood to be the largest pressure vessels ever fabricated out of aluminum. These tanks are used for the storage under pressure of petro-chemical products (nitrogen fertilizer solution) which are corrosive to conventional tank metals. This is an example of the petroleum industry's constant search for and use of new methods and materials.

Closeup view of enclosed motor showing breather for use in humid locations.

Drains on Enclosed Motors For Humid Locations

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WHILE the totally enclosed, fan-cooled motor can be cited as an outstanding example of progress in the quest for a better motor, danger lurks where it is installed in a humid atmosphere and does not operate continuously.

This results from an erroneous impression that such a motor is gas-tight and that interchange of air between that inside the motor and the surrounding atmosphere is impossible.

Even the exacting requirements of the Underwriters' specifications for explosion-proof motors recognize an interchange of air, "breathing," which, in many cases, has no adverse effect on the motor. The enclosure, in any case, is sufficiently tight to exclude dust or other solid matter which may contaminate the atmosphere and also tends to dilute corrosive gases which might also be present.

However, in a humid atmosphere where the motor does not operate continuously, a danger does exist. While running, the air inside the motor attains a temperature which, despite variations in the ambient temperature, will be maintained above the dew point. Upon shutdown, a sufficient drop in temperature may occur to cause some condensation of moisture contained in the air inside the motor. Repeated such occurrences could result in an accumulation of water in the bottom of the motor sufficient to flood the coils and cause a burnout. Once started, there is little chance for moisture to do anything except accumulate—evaporation is negligible.

There are two methods of guarding against this hazard:

(1) Use space heaters which function automatically through the motor control when shutdown occurs. Thus a temperature higher than dew point will be maintained, regardless of changes in ambient temperature. This method, in addition to its initial cost, creates a continuing operating expense.

(2) The more popular method is to use drains located at the bottom of the motor. In "standard" (unlabeled) motors the drain may be a tapped opening with a regular pipe plug which should be removed periodically to allow escape of accumulated water. Where "standard" (unlabeled) motors are permissible, it is possible that in many cases the plug is unnecessary.

In the case of explosion-proof (labeled) motors, a special drain valve (Figure 1) can be furnished, which continuously permits escape of moisture accumulation. Since the drain is, in effect, an opening between outside and inside of motor, it must have Underwriters' approval, and its attachment to the motor must be of a permanent nature. For this reason, factory installation is preferred.

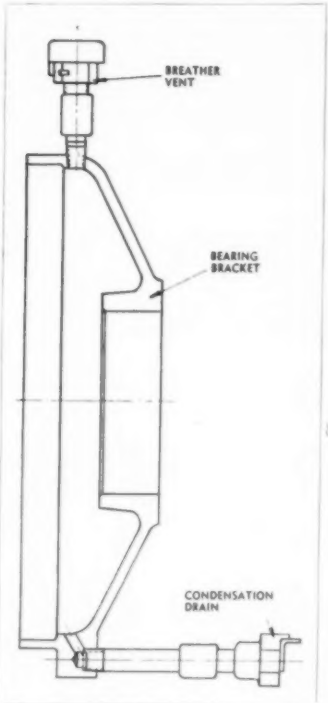

FIGURE 1

Breathers can also be applied, which, to some extent, relieve the condition of air flowing in or out through the bearing closures. These drains (and breathers) for labeled motors are either brass —for ordinary conditions—or chrome or monel metal where corrosive agents are present in amounts sufficient to warrant these higher-priced metals.

The Measurement of Luster Of Petrolatums and Waxes

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ONE of the most important properties of a petrolatum in the solid state is the appearance of its surface. It may have a surface which is almost as smooth as glass or its surface may be coarse and dull. When a customer opens a jar of petrolatum the appearance of its surface will, to a great extent, influence his decision concerning its quality. He will rightly prefer a lustrous petrolatum to one which is coarse or grainy. The luster of a petrolatum is therefore an important property from the practical viewpoint.

Although methods for determining the gloss of paint, enamel and paper are reported in the literature there is no reference to the measurement of the luster or glass of petrolatum or petroleum waxes. Therefore, this investigation was undertaken to overcome this deficiency.

Preliminary Work

For this work it was decided to apply a photovolt reflection meter with a 60° angle search unit, which is used for the measurement of gloss of paint, enamel, paper, etc. The apparatus consists of two parts: 1) a galvanometer and 2) a reflectometer. The reflectometer consists of a standard light source which emits parallel light at an angle of 60° against the surface to be measured. The reflected light impinges on a photo-electric cell which in turn activates the galvanometer. The smoother or glossier the surface, the more light is reflected. A dull or grainy surface scatters the light and gives low readings on the galvanometer.

To use the reflection meter successfully for such a test conditions must be met as follows:

1) The petrolatum or wax surface must be plane; it must contain no ridges. Even a mirror if it is wavy will not reflect parallel light in one direction.

2) The petrolatum surface must be perpendicular to the vertical axis of the search unit so that the reflected light can strike the photo-electric cell; and naturally a flat surface is all-important. This is difficult to achieve in the case of petrolatums and waxes because of their tendency to form a depression at the center on cooling in containers thereby yielding a concave surface.

3) The surface of the sample must always be at exactly the same distance from the light source of the search unit.

These requirements could not be met by filling a shallow container with the molten sample and allowing it to solidify, because petrolatums and waxes contract on solidification, and therefore the surface of the solid sample is invariably below the rim of the container and always has a concavity. Consequently, conditions under (2) and (3) could not be met. However, it was found that these conditions could be satisfied by dipping metal or glass plates into the molten sample and then withdrawing and allowing the adherent to solidify. Preliminary work showed that glass microscope slides 2 x 3 inches were satisfactory for this purpose. In order that the sample surface always be exactly the same distance from the light source of the search unit, a metal cover was attached over the base of the unit. This cover is provided with three protuberances arranged triangularly. The petrolatum-coated glass slide could then be pressed on the search unit so that the projections rested on the glass surface and at the same time the base proper could not touch the petrolatum surface and thereby distort it (Figures 1 and 2).

***METHODS** for determining the gloss of paint, enamel and paper are well known but even though the luster of a petrolatum is important from a practical—customer—viewpoint, there is no reference to the determination of this luster index. In order to meet this deficiency, the authors have devised a method which is reported herewith. Kinsel and Phillips have made previous contributions to PETROLEUM REFINER, their topics dealing with petrolatums and petroleum waxes.*

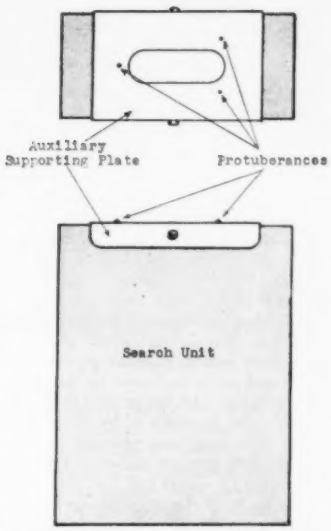


Figure 1. 60°-Angle Search Unit with Auxiliary Supporting Plate.

In order to calibrate the apparatus, a glass slide was ground on one side using No. 180 carborundum powder. When the photovolt reflection meter was set to read 100 percent reflectance on the smooth side, it read 4-5 percent reflectance on the ground side. This type of standard was used because it approximates the appearance of a petrolatum with the ideal surface—the smooth glass side reflects light like the ideal petrolatum surface would, and the ground glass side scatters any light which is not reflected by the smooth side just as the body of the petrolatum does. Experiments were made using the smooth and the ground side of the glass slides.

Smooth vs. Ground Glass Surface

Glass microscope slides with smooth and ground surfaces were dipped into a sample of petrolatum which was kept at different temperatures, and were allowed to solidify at room temperature after withdrawing the slides and keeping them in a vertical position. The dip-coatings made at higher temperatures yield thinner petrolatum

Table 1
Influence of Layer Thickness and Glass Surface Condition on Reflectance

Thickness of Petrolatum Layer* m.m.	Percent Reflectance	
	On Ground Side of Glass Slide	On Smooth Side of Glass Slide
No layer	4	10
0.02	72	82
0.11	66	78
0.42	66	70

* Determined by weight.

layers than those made at lower temperatures. The reflectance readings obtained from these samples are listed in Table 1.

The data in Table 1 indicate that very thin petrolatum layers tend to yield high results whether on smooth or ground glass surfaces. In the first case a large percentage of the light not reflected or scattered by the petrolatum layer is in turn reflected by the smooth glass surface and only a small percentage is absorbed or scattered by the body of the petrolatum. In the second case the net effect of a very thin layer of petrolatum is to fill in the depressions of the roughened surface thereby converting it into a smooth surface. This makes it desirable to use ground glass surfaces and to coat them under conditions which yield a reasonably thick petrolatum layer (0.1-0.3 mm.). For subsequent work slides ground on both sides were used.

Preparation of Petrolatum Surface

Dip-coating of the glass slides was made with the petrolatum kept at varying temperatures with results as follows:

a) The higher the temperature of the petrolatum, the thinner was the layer retained by the glass slide.

b) As the temperature of the petrolatum approached its melting point, the surface of the petrolatum on the glass slide tended to be very irregular.

c) The thickness of the layer retained on the glass slide depended not on the absolute temperature of the petrolatum during the dip-coating operation but on the difference between the temperature and melting point of the sample.

It was found that smooth surfaces of 0.1 to 0.2 mm. thicknesses were obtained by dipping the glass slides into the samples heated to 30° F. above their melting points, withdrawing the slides after they had been immersed for 60 seconds, and allowing them to drain in air while held in a perpendicular position. Consequently this technique was incorporated in the method.

Influence of Temperatures on Luster

In order to determine the influence

FIGURE 2

of surface temperature on luster, samples of a petrolatum were prepared in accordance with the previous paragraph and were then allowed to age at different temperatures. Luster readings were made at the temperature of aging (Table 2).

Table 2
Influence of Temperature on Luster

Thermal History of Samples	Percent Reflectance	
	Petrolatum A	Petrolatum B
Aged (1 hour) at 77° F.	64	30
Aged (1 hour) at 86° F.	75	51
Aged (1 hour) at 86° F. and then cooled to 77° F.	67	34

The data in Table 2 show that the temperature at which the luster is measured is of great importance. Of some importance is the temperature of aging. It was therefore decided to age the petrolatum-coated glass slides and to determine their lusters at 77° F.

Influence of Time of Aging

Samples of petrolatum were aged at 77° F. for varying time intervals and their lusters were determined at the same temperature (Table 3).

Table 3
Influence of Aging Time on Luster

SAMPLE	Percent Reflectance After Aging				
	2 Hrs.	5 Hrs.	24 Hrs.	48 Hrs.	120 Hrs.
Petrolatum A	66	69	70	73	71
Petrolatum B	31	34	35	37	40
Mineral Jelly A	26	26	27	26	27
Microcrystalline Wax A	9	10	10	10	11

It is apparent that the luster of a petrolatum surface changes very gradually with time but that the change due to aging is small. Since the rate of aging appears to flatten out after about 5 hours it was decided to age all samples overnight more or less as a safety measure.

Repeatability of Luster Measurement

Using the optimum conditions thus far listed, five slides were dipped per sample and their lusters were determined (Table 4).

Table 4
Repeatability of Luster Measurements

SAMPLE	Percent Reflectance	Avg.	Avg. Deviation
Petrolatum A	68, 70, 70, 71, 72	70	1
Petrolatum B	33, 34, 35, 35, 36	35	1
Petrolatum C	25, 25, 29, 31, 32	28	3
Mineral Jelly A	24, 25, 27, 28, 30	27	2
Microcrystalline Wax A	9, 9, 9, 9, 13	10	1

The average deviation (to the closest whole number) can be expected to be a maximum of 3. Hence in order to obtain an average figure it was decided to take at least five readings per sample, discard all readings varying by more than three from the mean and then average the remaining, provided that there are at least three.

Reproducibility of Luster Measurement

Samples were dip-coated on succeeding days using the procedure for determining average values.

Table 5
Reproducibility of Luster Measurements

SAMPLE	Percent Reflectance			Avg.	Max. Deviation from Avg.
	Run 1	Run 2	Run 3		
Petrolatum A	68	70	71	70	2
Petrolatum B	33	35	37	35	2
Petrolatum C	27	26	32	28	4
Mineral Jelly A	26	29	26	27	2
Petrolatum Stock A	19	27	23	23	4
Petrolatum Stock B	12	12	12	12	0
Microcrystalline Wax A	11	7	11	10	3

It is to be noted that the error in reproducibility is absolute, not relative, and that a maximum error of ± 4 can be expected in the results (Table 5). On a percentage basis the error is, of course, larger for the lower readings.

Procedure for Measuring Luster Index

The luster index of a petrolatum or petroleum wax is defined as its degree of luster or gloss when measured by a reflection meter under the conditions specified.

Apparatus

1) A photovolt reflection and gloss meter Model 610 (or its equivalent)[1] (Figure 3).
2) A search unit (Model 660-A) for 60° gloss tests fitted with auxiliary plate for holding glass slide (Figures 1 and 2).
3) Microscope slides (2 x 3 inch) with both sides ground.
4) Microscope slide (2 x 3 inch)

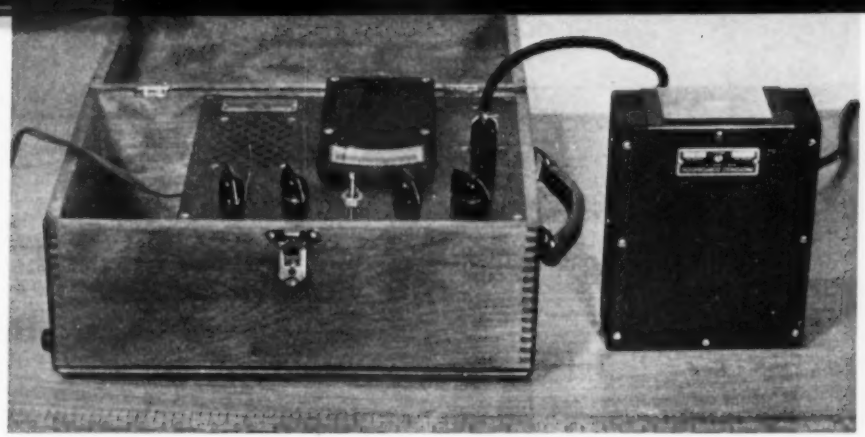


FIGURE 3

with one side ground.

5) A rack for holding the slides in position during aging (Figure 4).

As mentioned previously the search unit is fitted with a cover containing three protuberances spaced triangularly which enables the glass slide to rest on the unit and at the same time prevents the base of the unit from distorting the surface.

Method

Heat the sample to be tested in a vessel to 30° F. above its melting point. Dip into the molten sample five slides with both surfaces ground, keeping each slide immersed for at least 60 seconds. Remove the slides and allow to drain in a vertical position away from drafts till the sample congeals, making sure that no air bubbles have been trapped on the slides. Place the dip-coated slides in a rack in an air bath at 77° ± 2° F. for 16 to 20 hours.

The samples on the slides are now ready for testing. The reflectometer is set to read 100 percent when the smooth side of a clean microscope slide, which has been ground on the other side, is tested for gloss. The prepared sample is then placed on the search unit, pressed down so that the three protuberances touch the glass through the sample, and the gloss is read directly on the galvanometer in percent reflectance. This operation should be carried out as rapidly as possible, since the samples warm up when placed on the search unit, due to the heat given off by the lamp.

The average of all five readings are taken and those results which differ from the mean by more than five points are discarded. The average of the remaining readings (a minimum of three) is designated as the "luster index." When less than three readings of the required repeatability are obtained the test must be repeated.

Table 6

Luster Index of Some Petrolatums and Petroleum Waxes

SAMPLE	Melting Point, °F.	Penetration		Lovibond* Color 2" Cell	Visc. at 210° F., Secs.	Luster Index
		Cone	Needle			
Petrolatum A	112	220		2Y	60	70
Petrolatum D	114	180		35Y 10R	73	39
Petrolatum Stock C	116	125		dark	65	38
Petrolatum B	118	180		2Y	65	35
Petrolatum C	133	180		0.25Y	50	28
Mineral Jelly A	102	170		0.5Y	46	27
Petrolatum Stock A	125	100		dark	90	23
Petrolatum E	139	180		0.25Y	45	20
Petrolatum Stock B	133	75		dark	75	12
Paraffin Wax A	133		15	white	40	12
Microcrystalline Wax B	188		30	dark	75	11
Microcrystalline Wax A	158		30	0.5Y	70	10
Petrolatum Stock D	145	100		dark	90	9
Ozokerite	149		18	white	41	9

*Y—yellow; R—red.

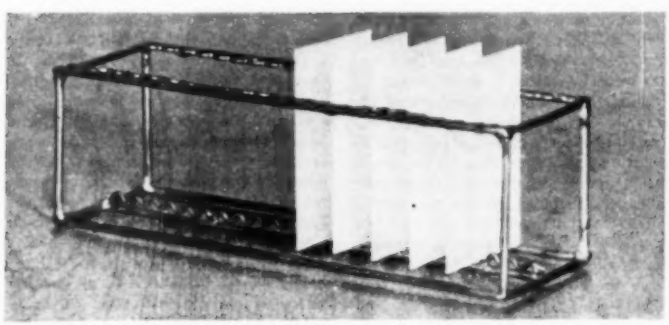


FIGURE 4

Experimental Data

In Table 6 are listed the luster indices of some petrolatums and petroleum waxes. The melting points were determined according to ASTM D-938-47T; the cone penetrations according to ASTM D-937-47T; the needle penetrations according to ASTM D-5-25; and the viscosities are all Saybolt Universal (ASTM D-88-44).

The data show that the luster index is not measured by the usual physical tests such as melting point, penetration or consistency, color, etc., but must be measured directly. However, the data do indicate certain tendencies:

1) The luster index is quite independent of the color and viscosity at 210° F. of the sample.

2) The softer samples (having higher penetrations) tend to have the higher luster indices.

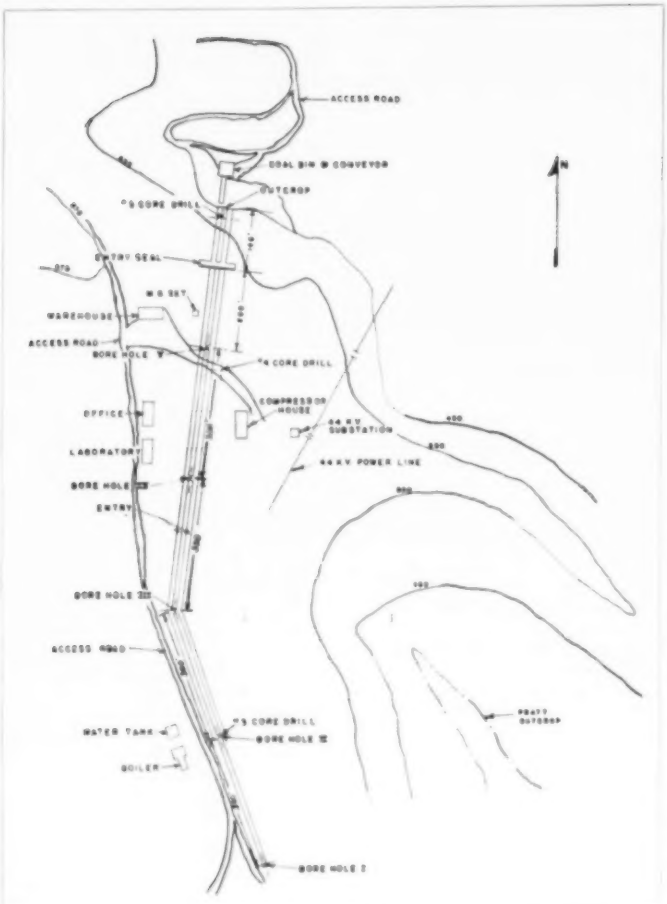
3) The samples with lower melting points tend to have the higher luster indices.

4) The petroleum waxes, whether micro- or macrocrystalline, all have approximately the same luster index.

REFERENCE

1 The photovolt reflection and gloss meter and the search unit were obtained from Schaar & Company, New York.

Underground Coal Gasification Project Developing



Plant Layout, Plant of Underground Coal Gasification Project Underway near Gorgas, Ala.

THE second experiment in underground coal gasification is under way near Gorgas, Ala., a cooperative exeperiment to gasify coal in place in the ground being sponsored by the U. S. Bureau of Mines and Alabama Power Company. Firing of the coal bed was scheduled late last month.

An initial field-scale experiment conducted during 1947 was successful and showed that gases produced by burning unmined coal offer a potentially cheap source of fuel for electrical power and raw materials for synthetic liquid fuels. Underground gasification also holds possibilities for utilizing coal beds difficult or uneconomic to mine.

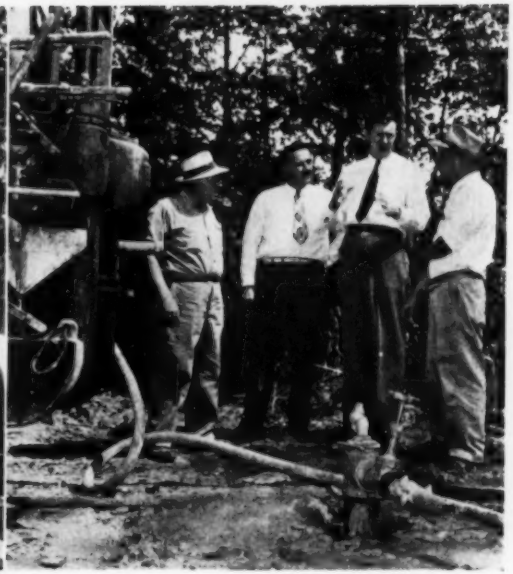
The first experiment demonstrated that combustion could be maintained and controlled, that coal in place could be gasified completely, and that the roof rock would become plastic and settle down behind the burning coal face without cutting off the air or gas. Owing to leakages through the thin (30-foot) cover over the burning coal seam, the product gas obtained was of lower heating value than desired. The new experiment is being carried out at a much deeper level (60 to 125 feet) and fuel gas of better quality is anticipated.

Milton H. Fies, manager of coal operations for the power company, and James L. Elder, chemical engineer for the Bureau of Mines, directed site preparation work for the new experiment, which has included driving two parallel entries for 1200 feet from the coal outcrop into the bed and a single butt entry for an additional 300 feet, drilling of five large-diameter boreholes to the coal seam at crosscuts linking the entries, construction of seals and gas or air connections at entry portals and at the surface outlets of boreholes, installation of equipment—compressor, blower, boiler, pump and water lines, and construction of laboratory, warehouse, and office facilities.

The plan of operation required that the project be fired at borehole I, as shown on the plant layout drawing. Air is admitted at this borehole, and the product gases removed from borehole II. All other outlets are blanked off. After the initial firing, the carbon dioxide content of the effluent gases will be built up to a maximum and the oxygen content held at a minimum by regulating the air flow to the system. Temperature of the effluent gases leaving borehole II are measured, and the temperature kept under 800° F. by use of a water spray. With air entering at I and the gases leaving at II, the flow is to be stepped up as rapidly as possible (maintaining zero oxygen in the effluent gases) until the maximum flow attainable is reached. This flow will be maintained and the quality of the product gases determined. If high temperatures and high carbon monoxide concentrations result, the operation will be continued, using this 300-foot passage until a steady state of operation has been maintained for a suitable period—that is, until gas quality begins to deteriorate. The system should provide a 300-foot, high-temperature zone for combustion and reduction plus a variable-length carbonization zone. The optimum length of path and the pressure drop that will be encountered will be determined. Temperature measurements taken at the test holes will give information as to the shape of the area in which the coal has been consumed.

Operation of the experiment will be continued until the maximum quantity of useful information is obtained. Progress of the combustion is estimated from the test-hole data obtained and from

A large diameter bore hole is sunk to the coal seam in preparation for the gasification experiment by the Bureau of Mines and Alabama Power Company. These bore holes will be sealed at the surface and fitted with pipe connections for either the air source or by-product gas disposal.



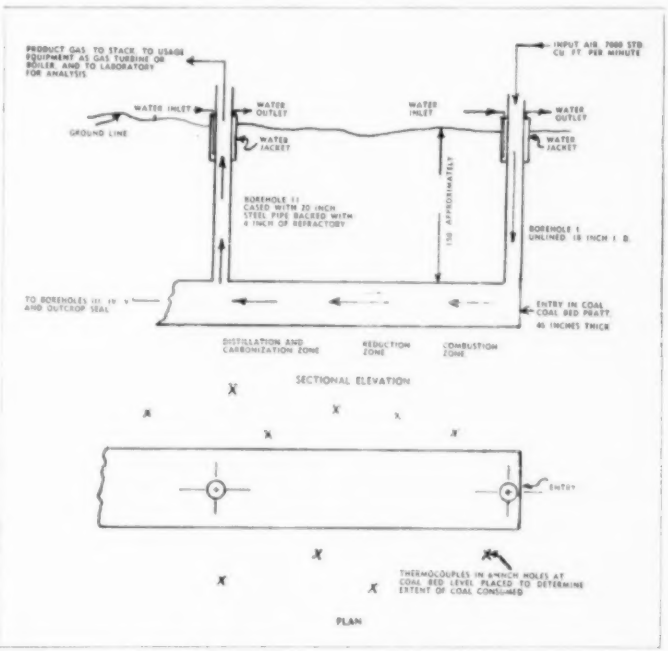
Dr. W. C. Schroeder, third from left, chief, Office of Synthetic Liquid Fuels, offers a suggestion to his aides, left to right, Hugh C. Graham, mining engineer; N. M. Speed, business manager; and James L. Elder, project supervising engineer. Bore hole being pressure grouted is shown in the foreground.

material and energy balances on the system.

At the conclusion of operations, the underground residue will be steamed and finally flooded with water and sealed. After the residue has cooled, entries may be driven in order to examine the residue. This final examination, together with material balances, will show whether coke in large quantities has been left underground and the effect of the combustion on the strata immediately overlying the coal bed. Flooding and sealing of the project after operations are concluded will prevent spreading of the combustion into adjacent coal.

If a high-temperature combustion zone can be realized and if the back pressures developed do not limit the flow too severely, it should be possible to produce a 70- to 125-Btu. per cubic foot product gas, using a unidirectional air blast.

Among the objectives of the experiment are 1) determination of the quantity of coal that can be gasified from a given combustion zone and the shape and extent of the burned-out area formed; 2) whether fixed outlets for product gas are practicable, either at the outcrop of the coal bed or at vertical borcholes (various designs of inlets, outlets, and seals will be tested); 3) determination of operating characteristics of the installation under a variety of conditions; 4) quality and quantity of product gas generated with an air blast under experimental conditions and the quantity of tar and related products obtained, and 5) to obtain fundamental technical and economic information concerning plant sites, installations, and operating processes.


PRODUCT GAS TO STACK, TO USAGE EQUIPMENT AS GAS TURBINE OR BOILER, AND TO LABORATORY FOR ANALYSIS
INPUT AIR, 7000 STD. CU. FT. PER MINUTE
WATER INLET
WATER OUTLET
GROUND LINE
WATER JACKET
WATER INLET
WATER OUTLET
WATER JACKET
BOREHOLE II CASED WITH 20 INCH STEEL PIPE BACKED WITH 4 INCH OF REFRACTORY
150 APPROXIMATELY
BOREHOLE I UNLINED 18 INCH I. D.
TO BOREHOLES III, IV, V AND OUTCROP SEAL
ENTRY IN COAL COAL BED PILOT 46 INCHES THICK
DISTILLATION AND CARBONIZATION ZONE
REDUCTION ZONE
COMBUSTION ZONE
SECTIONAL ELEVATION
ENTRY
THERMOCOUPLES IN 6-INCH HOLES AT COAL BED LEVEL PLACED TO DETERMINE EXTENT OF COAL CONSUMED
PLAN

Schematic Diagram of Underground Gasification Project.

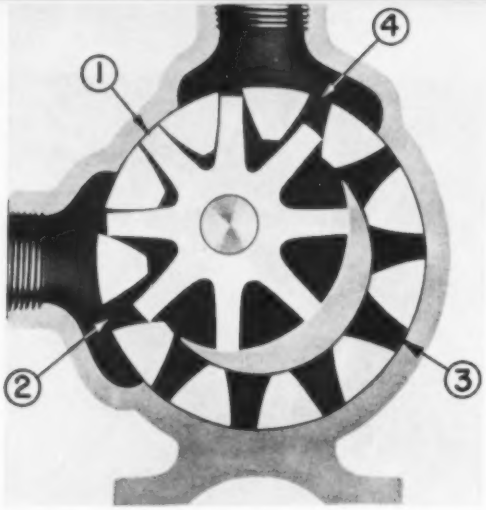


Figure 1—Cross section rotary pump. Outer teeth constitute rotor. 2 inlet, 4 outlet when rotating counterclockwise.

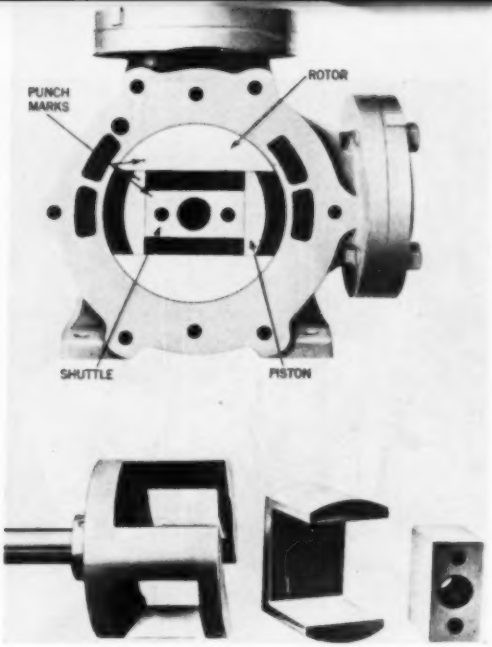


Figure 2—Positive displacement pump with rotor composed of three elements.

The Manufacture of Lubricating Grease

PART II—Processing Equipment

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MOST design and development of equipment for use in lubricating grease manufacture has been and still is based on empirical data. Of course some ideas are borrowed from other industries. The trend is to base new design upon scientific data as more fundamental knowledge becomes available.

Batch saponification at atmospheric pressure is the oldest method by which lubricating greases are manufactured, so the equipment, as a rule, is not as modern as that employed for other processes. However, since this equipment still is in use for finishing grease and since the auxiliary equipment remains the same, some detail will be given.

Batch Saponification at Atmospheric Pressure

Originally any kettle with some sort of an agitator would do a job of a sort. The older kettles, some of which are still in use, are of riveted construction with agitators consisting of straight bars 2½ or 3 inches wide, bolted to a shaft at about 18-inch intervals. Agitators of such kettles are driven, through bevel gears, by belts from a line shaft, tight and loose pulleys being provided. In some cases flat bottoms are used, but later kettles have either cone or dished bottoms. Fire heated kettles are single shell and those heated with steam or hot liquids are jacketed partially or completely.

Equipment for this process has been improved in a number of ways. In order to obtain better heat transfer, kettles were designed which would permit of the use of scrapers. The first to propose this were manufacturers of cast iron kettles. Manufacturers of welded steel kettles next produced vessels with a smooth, uniform surface so that agitators with scrapers attached could be used. When fat, mineral oil and alkali are first charged to a kettle and warmed, the mass is quite fluid and as long as agitation takes place the fluid next to the vessel wall will be displaced and reasonable heat transfer will result. However, as soon as part of the fat or fatty acids are converted to soap the mass becomes more

WHAT HAS to be accomplished in manufacturing lubricating grease?

First, if a grease plant makes the soap base, as most of them do, a chemical reaction (saponification) has to be carried on. This reaction should go to completion as rapidly as possible with a minimum expenditure of heat, labor and power. The speed and completeness of reaction will depend upon the factors, temperature, concentration and intimate contact of reacting ingredients, provided moisture is present.

Next, after the soap is formed it should be properly dispersed in mineral oil, a dispersion almost universally done thermally. Dispersion by mechanical means only has been attempted but we know of no such case where a satisfactory grease structure resulted. Chemical means sometimes are used for dispersion.

Finally, after dispersion the mixture must go through a stage of gel formation or crystallization. In some cases this will take place in a static condition while with other types of soaps continual movement during cooling is best.

Some lubricating greases will then be ready to package but others will have to be processed by milling, subjecting to final adjustments as to consistency and in some cases to removal of entrapped air.

viscous and heat transfer will be retarded if the portion next to the kettle wall is not removed mechanically. Huggins[1] compared a kettle without and with spring steel scrapers attached to the agitators and found the steam consumption to be reduced by one-third in the latter instance. A test was cited in which a mixture of aluminum soap and mineral oil was heated from room temperature to 275° F. in 90 minutes when scrapers were employed, while without scrapers the time was 459 minutes. Likewise, with water in the jacket, a batch of grease was cooled from 290 to 160° F. in 37 minutes when scrapers were used, whereas without scrapers the time was 97 minutes. If the same vessel is also used to finish grease, scrapers also have an additional advantage. Without such equipment heavy material would stick to the sides and in later stages might become loosened and then break into particles which never disperse.

Agitation has also been improved in order to get better mixing and more intimate contact of the reacting ingredients. Paddle arms are pitched so as to throw either up or down. Breaker bars welded to the sides of the kettles at points between paddles serve to break up the mass as it moves past. Two-way agitation is also used. This may consist of a set of stationary paddles attached to the shaft while another set of sweeps rotate, or a sweep may rotate in one direction and agitators in another. Further, variable speeds have been provided.

The source of heat varies. If direct fire is used the fuel may be gas, or coke. Steam is used at the pressure available, which is normally 100 to 125 pounds. Dowtherm is used to a limited extent and one plant depends upon circulation of hot oil as the only medium for heat transfer.

Electric motors are used universally as a source of power for grease manufacturing equipment. All new installations have individual drives, in some cases with two speeds and in a few instances vari-speed.

Venting Provision

Since both vapor and dust is driven off from open kettles some means of venting is provided. A sheet-iron hood placed above the kettle and connected with a duct going through the roof will carry off some fumes. Better still is a hood fitting the top of the kettle which is then connected with a suction fan. A tight lid can be made of thin steel welded to the kettle top. A stack attached to this can be 8 to 18 inches in diameter. Of course hinged doors are left for charging and for observation.

In older plants the finished grease was removed from the kettles by gravity and consequently the vessels were set high enough so that a drum could be rolled under the outlet. Many plants still prefer to suspend the kettles from the second floor so that there is head room below them on the ground floor. Since most grease is now removed from the kettles by pumps the necessity for head room does not prevail. However, pumps should be set as close to the kettle outlet as possible and this will mean underneath the kettle. For ease in charging and so that one operator can handle several kettles the vessels are grouped. In many plants they are arranged in two parallel rows with only space for piping and drives between.

The steam inlet and outlet to jacketed kettles can also be used for cooling water. The outlet for finished product should be 4 to 8 inches in diameter. This outlet should be provided with a flush valve so that soap or unreacted ingredients will not settle and act as a plug when the outlet is opened. Oil meters, with a manifold attached, are set on the top rim of the kettle.

Most kettles used for saponification in grease plants have recording thermometer connections. The thermocouple or thermometer bulb must be so placed that it will not interfere with the operation of the paddles or the scrapers and yet it must not become coated with grease or soap which will act as an insulator and thus prevent a true reading. If a bulb is inserted through the jacket of a vessel, clearance or airspacing should be provided so that the jacket temperature does not influence the reading. In some kettles which have a breaker bar attached to the inside shell at two points the bulb can be fastened to this so that a rigid location is provided. In other cases the thermocouple will be inserted through a bottom opening near the shaft. It is advantageous to have a thermocouple in the grease circulating line as well as in the kettle itself.

In addition to gauges to indicate steam pressure on the jacket of a kettle, a regulating valve is often provided so that processing can be carried on at different pressures at various stages of manufacture.

An ammeter for the operator to watch is advantageous in processing greases which pass through a very heavy stage. Ammeter readings can then be made a part of the compounding instructions so that the operator will know when to shift to a different speed of the agitators or when to add oil.

Twenty years ago most grease plants filled packages by gravity, depending upon the weight of the charge and the action of the agitators to force the grease out of the kettle. Pump equipment, now almost universally used to discharge grease kettles, has many advantages. It permits additional mixing by circulating the charge out of the bottom and into the top of the kettle. Also, it enables filters or screens to be placed in the line so that dirt and soap lumps can be removed. Further, delivery of the contents can be made at any point. Thus, if a filling machine is used, this need not be adjacent to the particular kettle being discharged. Many greases have to go through mills or deaerators and a pump is a logical means of delivery to such equipment.

Various Types Pumps Satisfactory

A number of makes and types of pumps have been found satisfactory for use in grease plants. One plant uses gear pumps. Often the gears are case hardened, so that better service life is obtained. Rotary pumps, Figure 1, have given good service and have the advantage that they will pass small pieces of metal without damage to the pump. Other designs of rotary pumps and gear pumps are likewise satisfactory. A tri-rotor pump, Figure 2, is valuable because of the variable volumn control obtainable. Any of these pumps should have pressure relief valves as protection.

The pumps used vary in size from 2 to 4-inch. A 2-inch pump which will deliver 50 gpm. of a fluid will deliver 20 to 30 gpm. of a lubricating grease. A 2-inch pump will be powered with a 5-hp. motor and 4-inch pumps will use 15 or 20-hp. motors.

Portable pumps are convenient where they are only used intermittently. A pump is set on a platform carried on castors and the inlet and discharge connections rigged with quick action couplings and sometimes with short lengths of flexible hose. In most cases the pump is wheeled to the kettle where it is wanted and connected in a matter of minutes. In other cases the pumps are used for processing and as an assurance against failure, as well as to decrease the processing time, two pumps are provided for one kettle.

In most grease plants the oils used, as well as the fats and some of the alkalies, are put through screens in order to catch dirt. In spite of this the finished product does contain some foreign particles and also some lumps of undispersed soap. For this reason

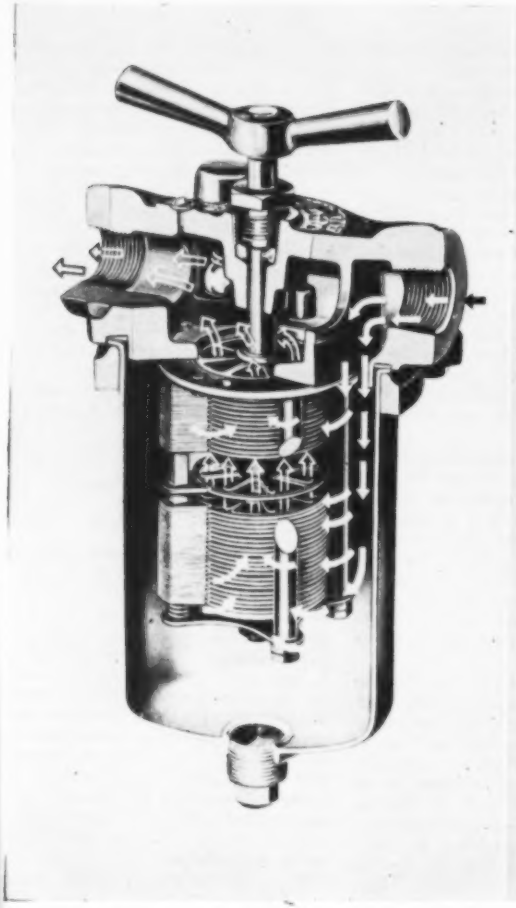

Figure 3—Cut-away view of a filter having an element composed of edge spaced plates.

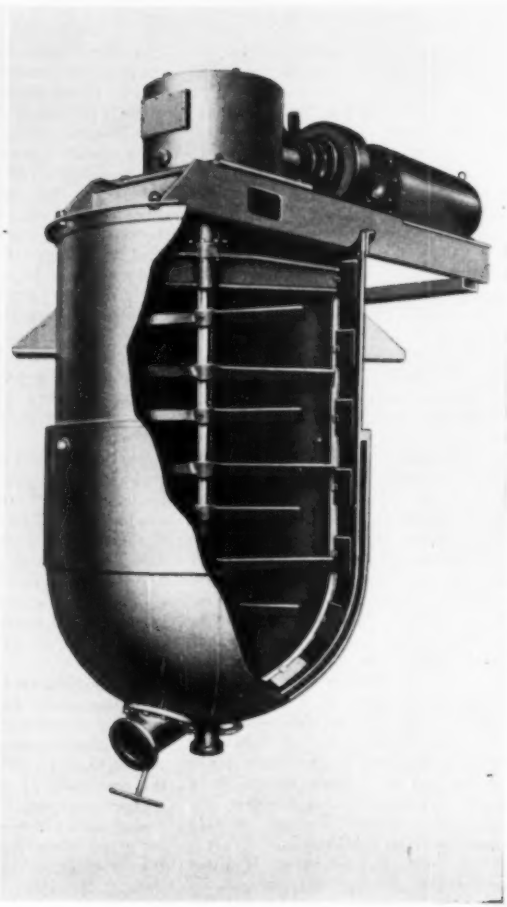

Figure 4—Cut-away view jacketed grease kettle.

most lubricating greases are screened before they are packaged.

As a means of screening, filter presses have been used. Klemgard[2] tells of a cylindrical 60-mesh screen cylinder of 4½ square feet of area, cleaned with a spiral screw scraper operating at 8¾ rpm. Other plants use a wire basket and still others depend upon flat discs of larger diameter than the pipe, some being 30 inches in diameter. Any screen will require a backing of heavier metal such as perforated metal.

Where wire mesh is used holes may develop and permit the passage of dirt before failure is detected. Some attempts have been made to detect this by the pressure drop across the screen, but a better method is to provide something more positive. Such equipment includes the filter, Figure 3, where the product to be screened must pass through a series of discs set on edge. The normal clearance of the opening for lubricating grease is .008 inch. The cleaners, which pass between the discs, can be actuated manually or by motor power. In the latter case the cleaning shaft rotates about 1 rpm. One plant uses one 3-inch filter while another depends upon three or four 2-inch filters placed parallel. If kept clean, a 2-inch Cuno will pass about 3000 pounds of grease per hour. Provision is made to purge filters through a bottom opening but this does not work satisfactorily with a plastic product and the head has to be removed frequently so that all tailings can be removed.

Typical Grease Kettles

Description of some typical grease kettles indicate what is being used. While reference may be made to some specific manufacturers it will be found that any good fabricator of pressure vessels can provide suitable equipment.

A series of fire-heated kettles are 6 feet in diameter and 6 feet high with 1250-gallon capacity. Between a 7½-hp. gear-in-head motor and the drive shaft of the kettle is a transmission taken from a motor truck. This provides four speeds, second giving a paddle speed of 16 rpm. and third a speed of 55 rpm.

In addition to a recording thermometer, a thermocouple is pasted to the outside of the bottom at a point where hot gas will not influence it. Too great a differential between the thermocouple and the thermometer reading indicates that part of the charge may be sticking to the bottom of the kettle and that local overheating may occur. These kettles have reverse dished bottoms so that drainage can be obtained without the exit pipe passing through a heated zone.

Since fire-heated kettles present a hazard, the above vessels are placed

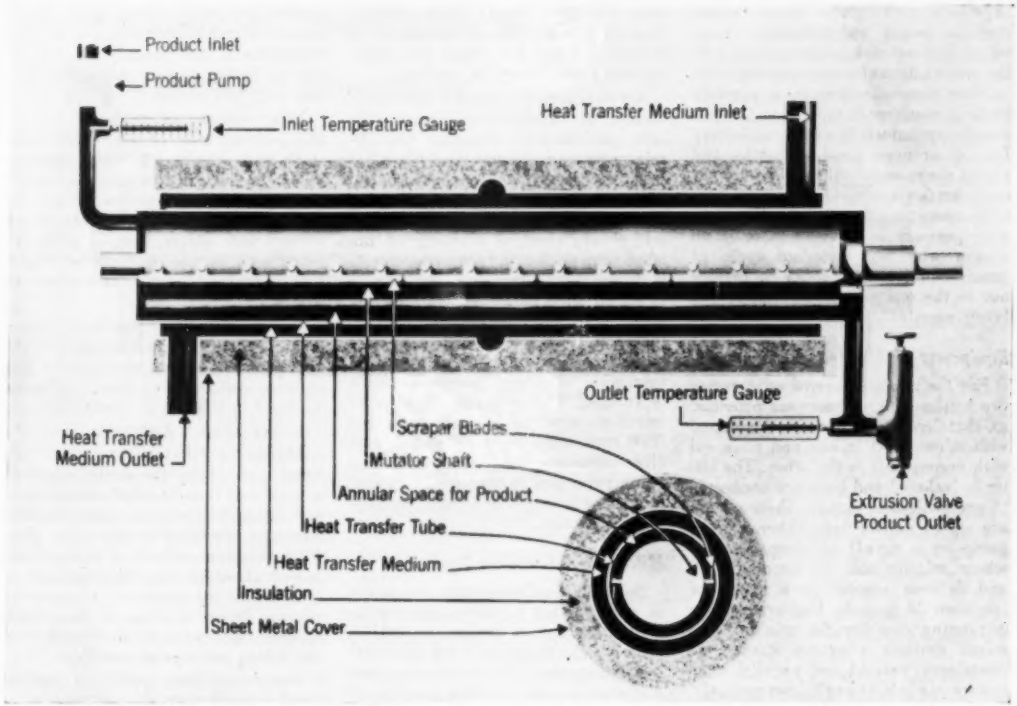

Figure 5—Cut-away and cross section views of heat exchange apparatus fitted with scraper blades to improve transfer rates.

between concrete block walls extending through and 3 feet above the roof. The only openings to other parts of the plant are through fire doors.

One plant, which considered direct fire too hazardous, installed a 60-barrel kettle heated with Dowtherm so as to obtain a higher heat than was possible with steam. The drive of this kettle is interesting since it consists of a fluid drive between a 40-hp. motor and the agitators. Double motion is simulated by having one set of stationary paddles fastened to the shaft and another set rotating. It is understood that the fluid coupling has prevented damage to agitators and gearing when the load became excessive.

Another plant, desiring to use a processing temperature of 500° F. and having 125 pounds steam, installed a superheater adjacent to the grease plant. While this did the job there was a lack of economy in the operation.

Standard kettles are available for grease manufacture, one design is shown in the cut-away view, Figure 4. This vessel is 6 feet i.d., 7 feet high on straight sides and has a capacity of 1900 gallons. It is driven by a 40-hp. 2-speed motor through a double motion drivehead which provides a speed of 22 and 11 rpm. on the inner agitators and 14 and 7 rpm. on the sweep. This is built to satisfy the ASME code for 200 pounds steam pressure. An 8-inch flush valve is provided for an outlet.

In order to simplify reduction gearing, another kettle of 2100-gallon capacity, is driven with a 50 hp., 2-speed, vertical motor. This kettle is for heavy service and has a 6-inch square shaft carrying paddles made from 4- by 1-inch steel bars, pitched so that the inner half of each paddle gives a down thrust and the outer half gives an upward thrust. To this kettle is attached a gear pump with a 4-inch suction and discharge, powered with a 15-hp. motor.

Equipment for Batch Saponification Under Pressure

The vessels used for pressure saponification are much like those used for saponification at atmospheric pressure except that they frequently are of smaller capacity. Thus, one manufacturer offers 300 and 500-gallon pressure vessels built to stand 150 psi. interior pressure. The open kettle shown in Figure 4 can be equipped with a dished and flanged top so that the vessel will be suitable for pressures up to 300 pounds.

In most installations pumps are not connected to pressure vessels because they are used for soap manufacture only and do not handle finished grease. In many cases the pressure cooker is set above the finishing kettles so that discharge is by open pipe. Even if the two kettles are set on the same level the pressure in the cooker is sufficient to discharge from its bottom opening to the top of the compounding kettle.

A pressure vessel of different design, installed in at least two grease plants, is termed a "pressure contactor." Oil heated to 500° F. is circulated through the jacket so that the temperature of the charge is brought to 370° F. and 70 psi. in less than 30 minutes, at which time saponification is complete. The high temperature keeps the charge quite fluid so that rapid circulation permits quick heating and intimate mixing. The circulation, through a narrow outside channel between two heated surfaces, is accomplished by an impeller set in a cone shaped bottom and driven at 1200 rpm. In a contactor of 6000 pounds capacity the nominal circulation is 3000 gpm. In the older models the impeller was driven by an electric motor, through a reduction gear, but the newer installations have a steam turbine drive.

Also available is a special oil heater

in which high-grade steam refined stock is heated and circulated. It is stated that no carbonization occurs in the system, even after two years service.

Since saponification in a pressure kettle is much more rapid than in open vessels one autoclave will provide soap for two or more finishing kettles and plants are so arranged that two or four open kettles are used in conjunction with one pressure vessel. However, once pressure is relieved there is no reason why the complete cycle of grease manufacture cannot be carried out in the one vessel; in fact, this is being practiced.

Equipment for Continuous Processes

For the manufacture of axle grease two kettles with agitators are provided so that hydrated lime can be mixed with mineral oil in one and rosin oil with mineral oil in the other. The latter is jacketed and both are connected to proportioning pumps. These pumps are set to deliver into either a third pump or a small mixing chamber where mixing will be accomplished and delivery assured in a matter of less than 30 seconds. One system uses a rotating disc for the mixing. This mixer delivers alternate streams to containers carried on parallel conveyors which travel intermittently. Either a stated volume is delivered to each container or a tilting platform actuates a cut-off valve on one side when a definite weight is delivered and then opens a valve on the other side of the conveyor.

Still another process uses special heat exchange apparatus, Figure 5, to manufacture either aluminum or lithium-base grease in a stream. The special process apparatus consists of concentric insulated cylinders with the material being processed passing through one section and the heating or cooling medium through another while blades remove the hot or cool film rapidly. Since this process uses preformed soap, two slurry tanks are provided in which the soap, oil and other ingredients are mixed by means of a propellor mixer. Since some air is entrapped in this mixing, the slurry is subjected to a vacuum before being fed to the exchanger.

At one plant a steam aspirator serves for this purpose. A pump set to deliver about 2000 pounds per hour draws from one slurry tank while the other is mixing. The stream of processing material passes from the heating chamber to a cooling exchanger and then to a gelling section which consists of insulated tanks. At one plant these are 4 feet square and 12 feet high with a 2 or 3-inch insulation. After a considerable period in these tanks the grease is either pumped through screens into containers or through another exchanger for working and perhaps further cooling.

A continuous process for the manufacture of calcium-base greases has been perfected by Standard Oil Development and a commercial plant has been installed. The soap is made batchwise under pressure in retorts holding 2000 pounds each. One of these vessels always contains a charge of finished soap so that the soap concentrate is drawn from alternate saponifiers. A steam-jacketed pump feeds a metering pump with this concentrate while at the same time a flowmeter delivers a stream of hot oil, the two streams entering a "disperser" where the grease is formed. The disperser consists of impellers attached to a shaft turning 3600 rpm. and corrugated stators with close clearance so that the material being processed is subjected to shear. Recycling is provided so that thorough mixing results.

Milling and Finishing Equipment

Some lubricating greases are cooled in pans so that a heavy cake results. With this type of grease, as well as some which are cooled in a kettle, milling is necessary. The above mentioned disperser is used for this purpose. A "homogenizer," Figure 6, is likewise employed for both milling and deaerating grease. This consisits of a hemispherical disc rotating at 900 to 1800 rpm. The grease is pumped into the center of this disc and is thrown to the outer curved edge by centrifugal action where it is picked up by the exit pipe in the form of a scoop. During this travel the product is smoothed out and since vacuum is maintained on the apparatus entrained air is removed. The nominal capacity of this apparatus is 210 pounds per minute but on heavy greases the delivery is less than half of this.

Other designs of mills are in use and perhaps some of the conical burr stone mills, popular 20 years ago, are still in service. At that time such mills were not only used to smooth out the product but also to mix lubricating greases with fillers. Colloid mills are being used by one producer who markets considerable grease containing fillers.

One problem in milling heavy grease is to get it to feed to a pump or mill. In some cases screws are used for this purpose and in other cases a plunger actuated hydraulically is employed.

Finished Product Handling

Drums of lubricating grease are filled direct from the kettle, run over a scale and then handled by conveyor to storage or shipping dock. Smaller packages are filled by machines. Most filling machines consist of plungers the stroke of which can be regulated to give a definite volume. A series of nipples deliver to a row of cans which then move forward as the cylinders of the filling machine are refilled.

Some equipment specific to particular lubricating greases will be mentioned as the manufacture of those types is taken up in the articles to follow.

LITERATURE CITED

[1] Huggins, F. E., GREASE MANUFACTURING EQUIPMENT, presented before Lubricating Grease Mfg. Assoc. 1935.

[2] Klemgard, E. N., LUBRICATING GREASES. Reinhold Publishing Co. 1937, page 132.

End of Part II. Part III will appear in the May issue.

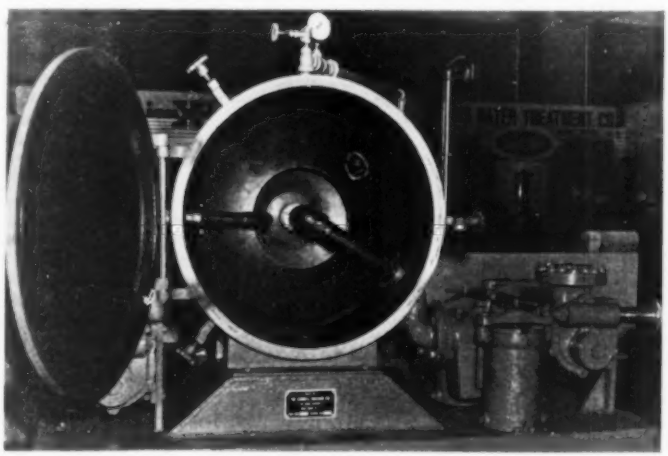

Figure 6—Homogenizer with vacuum chamber opened.

Applications of Thermodynamics To Hydrocarbon Processing

PART XVIII—Entropy Charts for Hydrocarbon Mixtures

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***A PROCEDURE** for preparing Mollier diagrams for hydrocarbon mixtures is described in this installment. In this method, the effects of temperature on entropy and enthalpy are obtained at the ideal gas state, while the effects of pressure are computed by means of generalized correlations, applied by the pseudo-critical concept. The estimation of a vapor-liquid phase diagram for the mixture is involved in these calculations.*

IN MOST hydrocarbon process design calculations, the process engineer is concerned with mixtures rather than, or in addition to, pure substances. For these calculations it is necessary to have a method of estimating the thermodynamic properties of the mixtures. This is a most complex problem due to the limitless number of hydrocarbon systems encountered in process engineering work.

Because of the large number of hydrocarbon systems involved, it is not practical to attempt the preparation of complete tables and charts for specific mixtures, except for special purposes. The most practical method appears to be a procedure for computing changes in entropy and enthalpy for different mixtures, as defined by average properties.

In the previous installment (Part XVII), rigorous and approximate methods of estimating the thermodynamic properties of pure components were outlined and illustrated. There are analogous (rigorous and approximate) procedures for mixtures also. These will be discussed in this chapter.

The compilation of thermodynamic properties for hydrocarbon mixtures might be divided into three parts: a) vapor-lined phase relations, b) effect of temperature on the properties, and c) effect of pressure on the properties. These operations are involved in all procedures, approximate and rigorous.

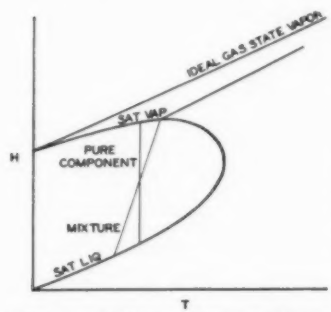


Figure 55 — Enthalpy — Temperature Diagram Showing Pure Component and Mixture Difference and Illustrating "Equivalent Component" Concept.

There are two types of methods that may be employed in deriving properties for mixtures: a) combination of pure component properties and b) treating the mixture as an equivalent pure component. Under each of these there are different alternate procedures.

The combination of pure component properties to obtain those for mixtures requires a procedure, such as the "partial quantity" method, that must be developed from consistent and precise properties of several typical mixtures and the components thereof. Mixture properties for this purpose should be computed by applying thermodynamic relations to the entire mixture.

Regardless of the procedure employed in calculating enthalpies and entropies of mixtures, it is still necessary to establish the bubble and dew point lines. This will be taken up separately.

Vapor-Liquid Phase Diagram and Latent Heats

Computing thermodynamic properties for the two-phase (liquid-vapor) region of a mixture is the most complicated operation, because vapor-liquid equilibrium conditions must be established to fix the *bubble* and *dew* lines, and the amount and composition of vapor before other properties may be calculated.

Figure 15 (Part VII, PETROLEUM REFINER, January, 1948) showed PVT plots for single and multi component systems. The plots in this figure illustrated the fact that constant pressure vaporization of a mixture occurs with increasing temperature. Likewise constant temperature vaporization of a mixture is accompanied by decreasing pressure. For a pure component, constant pressure vaporization occurs at constant temperature, and vice versa. Thus, the vapor pressure curve for a mixture is a phase border curve, consisting of a *bubble* line and a *dew* line.

In computing the thermodynamic properties of a hydrocarbon mixture, it is necessary to locate these lines and also take into account the change in temperature for constant pressure vaporization. Ragatz, McCartney and Haylett[4] recognized this situation in 1933 and proposed treating the mixture as an "equivalent pure cut" in computing the enthalpies of liquid and vapor at low pressures, where the vapor PTV behavior approaches that of a perfect gas.

Thus, Ragatz et al.[4] proposed constructing total heat (enthalpy) charts for mixtures by calculating the liquid and vapor enthalpies for an equivalent pure cut, having the same gravity and average boiling point, and locating the two curves relative to each other by a latent heat value also estimated for an equivalent pure component. Such a chart could be applied to mixtures if the bubble and dew points of the mixture are known.

Figure 55 illustrates the enthalpy-temperature diagram that might be developed for an equivalent pure component and applied to a mixture. The construction of such a diagram for pure components was discussed in Part XVII. The construction for an equivalent pure component is similar, with a few additional steps to take into account the phase relation of the mixture.

The "equivalent pure component" idea, proposed in 1933 by Ragatz et al.,[4] was materially advanced in 1936 by Kay with the development of the pseudo-critical concept (Part X, PETROLEUM REFINER, April, 1948), and correlations for predicting this average property of mixtures.

Correlations for estimating vapor-liquid phase equilibria and the pseudo-critical point are necessary auxiliaries in developing enthalpy charts for hydrocarbon mixtures. Phase equilibria will be taken up in later installments. For the present purposes it will be

sufficient to assume that the bubble and dew point lines of hydrocarbon mixtures may be estimated without specifying the manner in which it is done.

Latent heats of vaporization for mixtures were discussed in Part XIV, (PETROLEUM REFINER, 1948) where a method of estimating the effect of changing pressure during isothermal vaporization of a mixture was suggested. In the equivalent pure component method, illustrated by Figure 55, of estimating the latent heat of vaporization, this "effect of pressure" computation is not required.

Rigorous Evaluation of Properties for Mixtures

The precise method of computing thermodynamic properties of hydrocarbon mixtures is substantially the same as the procedure described in Part XVII for pure components, except that a phase border diagram is required instead of a vapor pressure curve. In addition to PVT data in the superheated vapor region, it is necessary to have PVTX (where X = fraction vapor) data in the two phase region to permit computing the latent heat of vaporization.

The effect of temperature on the enthalpy of mixtures is computed at the ideal gas state, using the values of C_p° or H° for the components of the mixture. At the ideal gas state the enthalpy of mixing is zero so the enthalpy is the summation of the values for the pure components and

$$H^\circ_{mixture} = \Sigma\, x_i\, H_i^\circ \qquad (323)$$

where:

$H'_{mixture}$ = enthalpy of the mixture in the ideal gas state above an arbitrary datuum.

x_i = mole fraction of component "i".

$H'_i = \int_{T_a}^{T} C_p'\, dT + H_{ai}' =$ enthalpy of component "i" in the ideal gas state.

For the calculation of ideal gas state enthalpy by equation 323, the tabulated values of Rossini et al.[5] for H° are recommended. In the application of equation 323, x_i may be weight fraction when H_i° is in Btu. /lb. but it is better to define it as mole fraction to avoid confusion.

The effect of temperature on the entropy of mixture is likewise computed for the ideal gas state, using the values of C_p° for the components. At the ideal gas state the entropy of mixing is not zero and must be included. The entropy of mixing of ideal gases may be shown to be

$$S = -R \Sigma\, x_i \ln x_i \qquad (324)$$

where:

x_i = mole fraction of component "i".

Combining equation 324 with the ideal gas state entropies of the pure components gives the folowing equation for the ideal gas state entropy of a mixture.

$$S'_{mixture} = \Sigma\, x_i\, S'_i - R \Sigma\, x_i \ln x_i \qquad (325)$$

where:

$S'_{mixture}$ = entropy of the mixture in the ideal gas state above the entropy of the pure components at an arbitrary datuum.

x_i = mole fraction of component "i".

$S'_i = \int_{T_a}^{T} \frac{C_p'}{T}\, dT + S'_{ai} =$ entropy of component "i" in the ideal gas state.

Values of S'_i are given by Rossini et al.[4] The entropy of mixing term in equation 325 is necessary for calculations on processes where the composition is changing. For a fixed composition mixture this term is a constant at all conditions of T and P and may be omitted.

Equations 323 and 325 would also be used in the approximate method of computing entropy and enthalpy values for mixtures.

The effect of pressure on the enthalpy of a hydrocarbon mixture may be calculated from the PVT data in the same manner as for pure hydrocarbons. The equations and procedure for this calculation have been presented in previous installments. In terms of the volume residual for the mixture, the isothermal effect of pressure on the enthalpy is

$$(H - H')_{mixture} = \int_a^P \left[T \left(\frac{\partial a}{\partial T}\right)_P - a\right] dP \qquad (326)$$

A similar equation may be written in terms of the compressibility factor Z.

By using equations 323 and 326 with the values of C_p° for each component and values of the volume residual as a function of P and T, the effects of temperature and pressure on the enthalpy of a vapor mixture may be computed.

The effect of pressure on the entropy of a mixture may likewise be computed by the same equation and procedure used for pure components. These equations have also been presented in previous installments. In terms of the volume residual for the mixture, the isothermal effect of pressure on the entropy is

$$(S - S')_{mixture} = -R \ln P + \int_a^P \left(\frac{\partial a}{\partial T}\right)_P dP \qquad (327)$$

By means of equations 325 and 327, with the values of C_p° and values of the volume residual as a function of P and T, the effects of temperature and pressure on the entropy of a vapor mixture may be computed.

Pseudo-Critical Method

The isothermal effects of pressure on the entropy and enthalpy of hydrocarbon mixtures may be estimated by means of the generalized correlations of $-\Delta H/T_c$ and $-\Delta S'$ as functions of T_r and P_r, given as Figures 48 and 49 in Part XVI, (PETROLEUM REFINER, February, 1949), and applied to mixtures by means of the pseudo-critical conditions, which procedure was illustrated and compared with precise values for mixtures in Part XVI.

This method is not claimed to give precise results but will give consistent values that are approximately correct, as was demonstrated in Part XVI. With the generalized pseudo-critical method of calculating the isothermal effects of pressure, the summation of ideal gas state values, as represented by equations 323 and 325, will be used to calculate the effect of temperature on the properties.

Combining equation 323 with the generalized reading from Figure 48 gives

$$H_{mixture} = \Sigma\, x_i\, H^\circ_i - T_c \left(\frac{-\Delta H}{T_c}\right) \qquad (328)$$

The $\left(\frac{-\Delta H}{T_c}\right)$ term is defined by equation 318 (Part XVI) and is given as function of T_r and P_r in Figure 48.

A similar equation may be written for the entropy by combining equation 325 with the RlnP and the residual entropy terms, see equation 315 and Figure 49 (Part XVI).

$$S_{mixture} = \Sigma\, x_i\, S'_i - R \Sigma\, x_i \ln x_i - R \ln P + \Delta S' \qquad (329)$$

The residual entropy $\Delta S'$ is given as a function of T_r and P_r in Figure 49.

In equations 328 and 329 the terms containing Σ signs are evaluated by summations from the composition and component properties. The R lnP term is only a function of pressure, being independent of the method used in handling the mixture. The other terms are evaluated for the mixture as a whole using the pseudo-critical and generalized correlations.

The effect of pressure portion of equation 328 was demonstrated in Part XVI for 14 mixtures of light hydrocarbons. The comparisons given in Tables 44 and 48 show that this generalized procedure using the pseudo-critical is a fairly good approximation. This plus convenience recommend it for engineering calculations.

Later this method will be compared

with the additive combination of the individual isothermal pressure correction values to show the order of magnitude of the heat of mixing at high pressures.

Equivalent Component Method

Perhaps the easiest way of obtaining a set of enthalpy charts for hydrocarbon mixtures is to cross plot the enthalpy values from pure hydrocarbon charts against molecular weight or gravity and then replot equivalent component charts from these cross plots. This gives enthalpy as a function of three variables: temperature, pressure and molecular weight; requiring a series of charts.

The most convenient way of preparing such charts is to plot enthalpy vs. temperature for lines of constant molecular weight all for a fixed pressure, making a different chart for each pressure (i.e. 50, 100, 150, 200 psi., etc.). This procedure is more convenient than having pressure parameters on each chart because it is frequently necessary to make several readings at the same pressure but with varying temperatures and molecular weight for process design calculations. Also it is frequently possible to use the nearest pressure charts due to the relatively small effect of a small (5 to 10 psi.) pressure difference on the enthalpy.

This equivalent component method is weakest near and in the two phase (vapor and liquid) region, where the use of averages is uncertain. For liquids below the bubble point and for super-heated vapors, mixtures might be characterized by the average molecular weight providing all the components are of the same type. When the mixture contains more than one type of hydrocarbons (i.e. paraffins, isoparaffins, olefins, etc.) this average molecular weight method of characterizing a hydrocarbon mixture is even more approximate.

Improved equivalent component enthalpy correlations for hydrocarbon mixtures could be developed by using another average property of the mixture, in addition to average molecular weight, to characterize the mixture. This additional property might be the atmospheric boiling point, the dew point or the average of these, which would be the boiling point of an equivalent component. The molar average boiling point may be used alone or with the average molecular weight in characterizing equivalent components.

One would expect the average molecular weight to be better for correlating the effect of temperature on the enthalpy because of the dependence of heat capacity on molecular weight. On

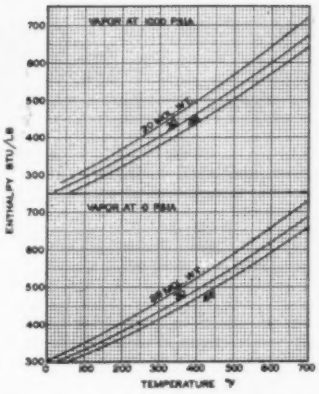


Figure 56 — Typical "Equivalent Component" Enthalpy—Temperature Plot for Hydrocarbon Vapors.

the other hand, it would appear that the average boiling point would be better for correlating the isothermal effect of pressure because of the variation of critical constants with average boiling point. To the writer's knowledge, both average molecular weight and molar average boiling point have been used in correlating enthalpies by the equivalent component method. Estimating the pseudo-critical constants of a mixture is not much more work than calculating the average boiling point so the generalized pseudo-critical method might as well be used for the effect of pressure.

Figure 56 is a plot of vapor enthalpies against temperature for three molecular weights (20, 30 and 40) and two pressures (0 and 1000 psia.) and illustrates the average molecular weight equivalent component method of correlating enthalpies for mixtures.

Scheibel and Jenny[12] (see also article by Scheibel[13]) published in 1945 three enthalpy nomographs for hydrocarbons, hydrocarbon mixtures and petroleum fractions. Both liquid and vapor enthalpies are given. The pure component charts are for the normal paraffin hydrocarbons: methane through n-octane. The enthalpy nomograph for light hydrocarbon mixtures was developed on the "equivalent component" basis using average molecular weight as the means of characterizing the mixture. In obtaining a readable grid for this nomograph the authors included a variable adjustment to the datuum.

The petroleum fraction enthalpy nomograph was based on the "equivalent component" assumption, using API gravity to characterize the fraction. This chart also has a datuum adjustment. These three nomographs condense a great deal of information in a small space. However, they are not very convenient to read.

Partial Thermodynamic Properties

Partial molal quantities are useful in combining properties of mixtures, particularly aqueous solutions and binary mixtures where there is an appreciable heat of solution or mixing. Data on the properties of the mixture are required in deriving the partial quantities. The property most frequently treated in this manner is the volume.

Enthalpy and other thermodynamic properties can be combined in this manner also. Figure 57 illustrates the partial enthalpies of a binary mixture where the enthalpies are not additive. In Figure 57 the solid curve is a plot of enthalpy vs. composition for a fixed condition (i.e. constant temperature and pressure). The tangent drawn as a dashed line at 40 percent A intersects the 0 and 100 percent A compositions at $\bar{H}_B$ and $\bar{H}_A$, respectively. These intercepts are the partial molal enthalpies of component B and A in the mixture of 40 percent A and 60 percent B.

It will be noted that these intercepts are above the intercepts made by the solid curve. This means that the partial molal enthalpies of A and B in the mixture are greater than the enthalpies of pure A and pure B at the same conditions of temperature and pressure. At other compositions, the tangent will have different intercepts or partial enthalpies. At the limit of 100 percent A the partial enthalpy of A equals the pure component enthalpy of A, i.e. $\bar{H}_A = H_A$. Likewise, $\bar{H}_B = H_B$. At these limits the partial enthalpy of the other component is the opposite intercept of the tangent to the enthalpy curve at the pure component composition involved.

If the enthalpy vs. composition curve is concave instead of convex (as

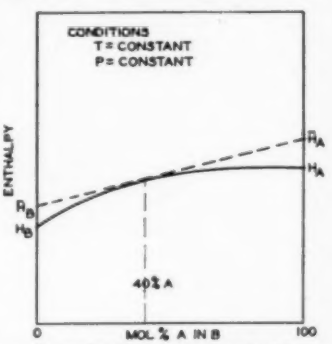


Figure 57—Graph Illustrating Partial Enthalpies for Binary Mixture.

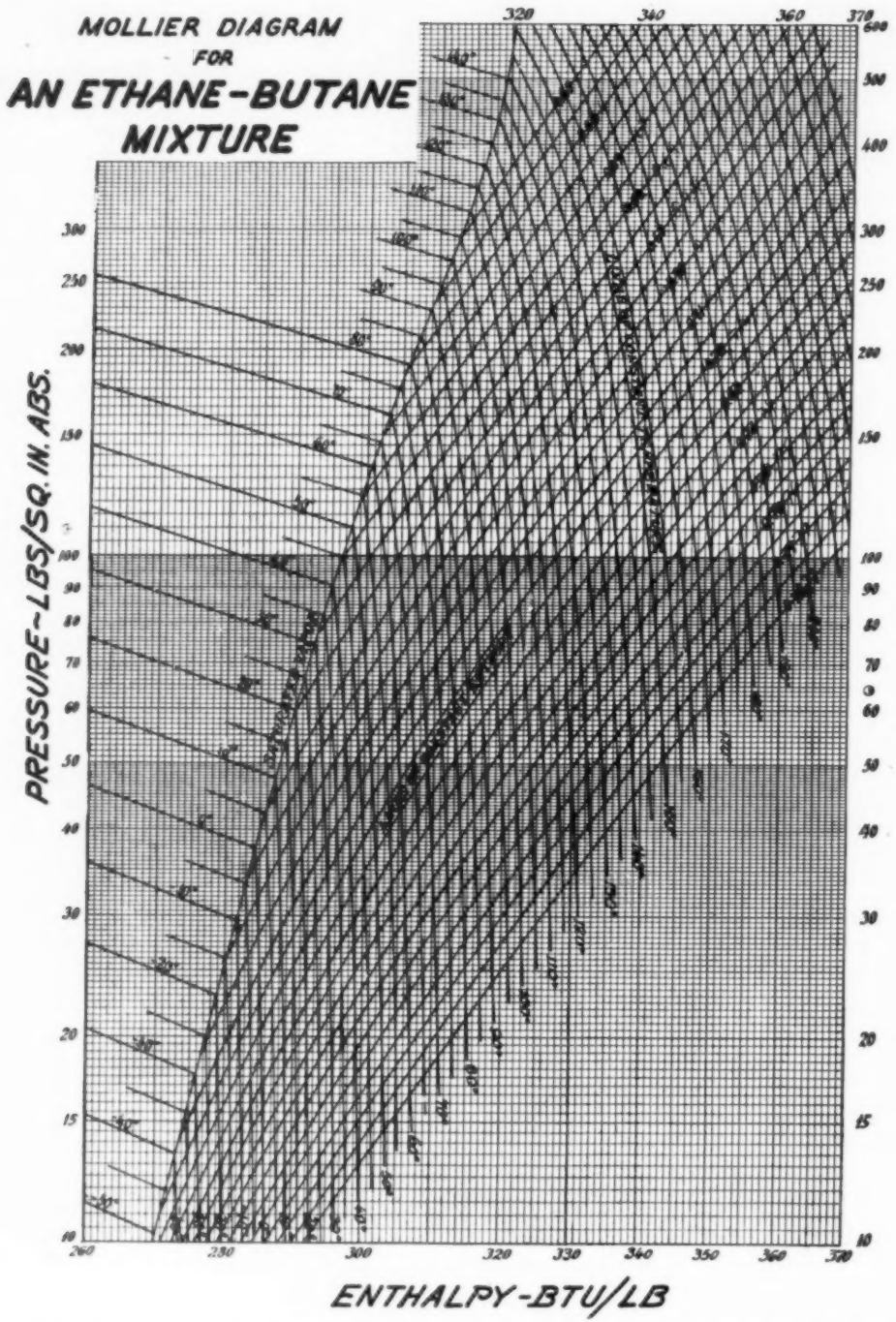


Figure 58—Mixture Mollier Chart to Illustrate Approximate Method of Compilation Datum: Saturated Liquid at —200° F. (See Table 53 for Saturated Liquid Enthalpy. See Text for Composition.) Source: Laverty and Edmister.[3]

shown in Figure 57), the partial enthalpies will be less than the pure component enthalpies because the tangent intercepts will be below those of the mixture enthalpy curve.

From the partial enthalpies, one may compute the mixture enthalpy by

$$H_{AB} = x_A \overline{H}_A + x_B \overline{H}_B = \Sigma x_i \overline{H}_i \quad (330)$$

The first part of equation 330 is for a binary system, while the last term is general and may apply to a mixture of two or more components. For multicomponent systems the partial enthalpies should be evaluated from data on the particular system involved with changing compositions. This gets rather complex, both experimentally and from a calculation standpoint.

Sage, Olds and Lacey[8] derived the partial enthalpies for four light hydrocarbons in binary hydrocarbon systems and combined these values to obtain the enthalpies of natural gases. These results were compared with similar values computed by the pseudo-critical application of generalized correlations.

The combination method used by Sage et al.[8] was based on some assumptions regarding the behavior of the various hydrocarbons in the natural gas mixtures. These assumptions were necessary because binary system partial enthalpies were being used to compute multicomponent enthalpies. Methane, which is a notorious bad actor, was handled by using three partial enthalpies, i.e. in ethane, butane and pentane. These were combined in accordance with the relative amounts of C_2, C_4 and C_5 present. It was further assumed that propane and isobutane had the same partial behavior as n-butane.

This work is an interesting and worthy contribution on the subject but is somewhat limited in application. More enthalpy data on mixtures, particularly multicomponent systems, are required to permit developing this method.

It would appear that the most promising partial enthalpy combination procedure would be on the isothermal effect of pressure thus leaving out of the calculations the effect of temperature and also the zero enthalpy datuum question. It might be that the partial enthalpies combination procedure could be used to determine corrections or refinement that might be made to the pseudo-critical generalized values of the isothermal effect of pressure on the enthalpy. In this way a more practical method might result.

What appears to be a difficulty in the partial enthalpy method is the combination of enthalpy values for a vapor mixture at conditions where one or more component would be liquid if pure. A similar problem would exist in the combination of partial enthalpies for liquids at conditions where one or more component would be vapor if pure. In both of these cases, the mixture might be close to the saturated vapor curve, which involves phase equilibrium calculations as well.

Sage, Olds and Lacey[10] proposed, in 1946, tentative partial enthalpies of the first five normal paraffin series hydrocarbons in both liquid and vapor phases. This work was an extension of their earlier[8] work. This compilation is a very worthy contribution to the technical literature.

From these data Sage et al.[10] can compute the partial enthalpy change of a hydrocarbon on solution in a heavier hydrocarbon or oil. They do this for methane and ethane and compare the results with similar values estimated by them for these same components by the Scheibel-Jenny nomographs and this author's enthalpy charts, as presented in Figures 50 and 51 in Part XVII.

The comparison of these results, as given by Sage et al., can be very misleading. In the first place the author's charts and additivity method for estimating the enthalpies of hydrocarbon mixtures was never proposed for calculating heats of solution, nor were the Scheibel-Jenny nomographs. These two methods can be used to estimate changes in enthalpies for entire systems but not the changes in the partial enthalpy of any component. This is possible because the lighter components always occur in small percentages so errors in the partial enthalpy change have a proportionately small effect.

In the next section, the technique proposed in 1938 for combining pure component enthalpies to get values for mixtures will be described. This is the procedure used by Sage et al.[10] in obtaining the values of the partial enthalpy change on solution credited to the writer in 1946.

Additive Combinations

The simplest, and perhaps most widely used, method of computing enthalpies for hydrocarbon mixtures is to assume additivity. This method was used in Butane-Propane Handbook.[5] Under some conditions an additive combination is satisfactory, but such a simplification can lead to large errors if not used discretely.

As pointed out earlier in this installment, it is correct to add the ideal gas state enthalpy. Adding other properties is incorrect to a varying degree. One would not add vapor pressures of components in a mixture to get the vapor pressure of a mixture. Instead it is necessary to calculate the boiling and dew points by means of equilibrium ratios, which under some conditions might be the ratios of vapor pressure to the total pressure. Latent heats of vaporization cannot be added with any degree of accuracy. Where the heat of mixing is zero, the isothermal effects of pressure may be added. It can be seen that caution must be observed in combining thermodynamic properties to get those for mixtures.

In Part XVII hydrocarbon enthalpy charts developed by Edmister and Pollock[2] were presented as Figures 50 and 51. When these charts were developed they were intended for applications to mixtures, which has been their main use during the past decade. Before these charts were first put into use, they were tested by heat balances on plant data and found to be satisfactory. It is now recognized that the use of these charts in calculating mixture enthalpies has definite limitations, as will be shown later in this installment.

The temperature, pressure and phase conditions encountered in most heat balance calculations involving light hydrocarbons are frequently such that either one or both of the following phenomena exists: a) a liquid hydrocarbon mixture at a temperature higher than the critical temperature of some of the lighter components therein; and b) a vapor hyrocarbon mixture under a pressure higher than the vapor pressure of some of the heavier components therein.

In other words: a liquid mixture may contain light, low boiling components at conditions under which these light components would be in the vapor phase if pure; and a vapor mixture may contain heavy, high boiling components at conditions under which these heavy components would be in the liquid phase, if pure.

The method proposed by Edmister and Pollock[2] for using the pure component charts (Figures 50 and 51) for mixtures provided for these two situations by the following assumptions, covering the chart reading steps:

Liquid Mixtures: a) Enthalpies for components whose critical temperatures are above the temperature of the mixture are the same as the enthalpies of the saturated liquid of the pure hydrocarbons at the temperature of the mixture; b) components whose critical temperatures are below the temperature of the mixture are assumed to be at a hypothetical liquid state and their enthalpies are assumed to be the same as the enthalpies of the pure hydrocarbons at the extrapolated vapor pressure and the temperature of the mixture.

Vapor Mixtures: a) Enthalpies for components whose vapor pressures are higher than the pressure on the system are the same as the enthalpies of the pure hydrocarbons at the temperature and total pressure on the mixture; b) components whose vapor pressures are lower than the pressure on the system are assumed to be at a hypothetical vapor state and their enthalpies are the same as the enthalpies of the saturated vapor of the pure hydrocarbons at the temperature of the mixture.

In setting down these simple rules for chart reading the authors[2] were assuming that the vapor-liquid phase equilibria relationships were known or could be estimated independently from the enthalpy computations. In other words, the saturated vapor (dew point) and saturated liquid (bubble point) lines were separately established.

The "extrapolated vapor pressure" lines on the heat-temperature graphs in Figures 50 and 51 were constructed by finding temperatures corresponding to the even values of the pressure (on the HT diagrams) from a Cox-type vapor pressure plot, where the lines were extrapolated above the critical point, and locating this same line on the HT diagram.

Referring to Figures 50 and 51 in Part XVII, the "extrapolated vapor pressure" lines can be seen as starting at the critical point on the two phase dome and going to higher temperatures and pressures, with increasing enthalpy values. It will be noted that these lines are curved at both ends but are substantially straight in between. This shape is due to the shape of the pressure parameter on the enthalpy versus temperature coordinates and not to the P-T relationship in the extrapolated region. It will be recalled that log P vs. 1/T is practically a straight line, even in the extrapolated vapor pressure region.

Using this extrapolated vapor pressure line as a hypothetical liquid line permits estimating enthalpies for components in mixtures. This procedure has no theoretical justification whatever. It is merely an expedient. The idea was suggested by a similar vapor pressure extrapolation that is made in the estimation of fugacity vapor-liquid equilibrium ratios for multicomponent systems. In this case a hypothetical liquid phase for the individual light low boiling components is also assumed.

In addition to the above methods of reading the enthalpy charts for components of mixtures, the assumption of enthalpy additivity was made. Since the enthalpy scales were BTU/lb., the enthalpies were combined on a weight fraction basis.

Referring again to the extrapolated vapor pressure line on the graphs in Figures 50 and 51, it is difficult to believe that the enthalpy of a component in a liquid mixture will change as abruptly at and near the critical temperature as do the values read from the pure component saturated liquid line and its continuation, the "extrapolated vapor pressure" line.

It would appear that the hypothetical line should be more gradual without the dips near the critical. Such a hypothetical liquid line could be plotted very easily by following a high pressure, say at P_r=2.0 from a point well below the critical temperature, where the high pressure lines either coincide, overlap or come very near to the saturated liquid line, to higher temperatures as desired. Such a line would be smooth with a gradual reverse curvature but not as sharp as the hypothetical liquid lines shown on Figures 50 and 51.

These pure component "total heat" charts, as they are frequently referred to by petroleum process engineers, were applied in two different ways in heat balance (more correctly: "enthalpy balance") calculations, namely: by overall heat balances and by component net heat balances.

In the over-all method the enthalpy of each stream (i.e. hydrocarbon mixtures) was calculated above the chart datuum point and then the total heat quantities "in" and "out" were computed. This involved large totals, which were misleading, particularly in judging the accuracy of the heat balance. A large "unaccounted for" item might be a small percentage of the total.

Net component heat balances were more indicative of the actual operations because the net changes in each component were calculated. For these calculations the pure component charts with the hypothetical liquid lines were very convenient. Net component heat balances were only used for fractionators and other separation units where there was no reaction.

As pointed out in the previous section, the hypothetical liquid lines on the graphs in Figures 50 and 51 should not be used to estimate heats of solution or the partial enthalpy change in solution.

Mixture Mollier Diagrams

In Part XVII three approximate hydrocarbon Mollier diagrams were included as Figures 52, 53 and 54 to illustrate the type of charts that can be constructed with very few data and a generous use of the generalization and estimation methods. The source and development of Figures 52 through 54 were given. Mixture charts were developed at the same time and by the same manner. (Reference 3 gives the first publication.)

By applying both the additivity and the pseudo-critical methods, described above, to four mixtures, Mollier charts were developed. These charts are given as Figures 58 through 61, inclusive. The temperature and pressure ranges were limited because of the applications for which the charts were intended. Following are the compositions of the four mixtures:

Figure	Hydrocarbon	Mol Percent
58	Ethane	82.3
	n-Butane	17.7
		100.0
59	Methane	0.80
	Ethylene	1.11
	Ethane	3.20
	Propylene	23.42
	Propane	71.41
	n-Butane	0.06
		100.00
60	Propylene	79.0
	Propane	21.0
		100.0
61	Propane	20.0
	n-Butane	80.0
		100.0

As was pointed out in Part XVII these Mollier charts were prepared for use in making some comparative calculations on different refrigerants. Figures 58 and 60 are mixtures having the same atmospheric boiling point as propane, while Figure 59 is for a typical plant stream. Figure 61 is for a mixture chosen at random. No attempt was made to develop complete and precise charts. For one thing, the entropy values do not refer to the components but rather to the mixture at the datuum (saturated liquid at —200° F.).

It is believed that the superheated vapor regions are fairly accurate, however, as M. Benedict spot-checked the plant propane chart by means of the Benedict-Webb-Rubin equation of state, combining constants for the pure components.

In the original form these charts included a saturated liquid line but these have been removed to save space and the saturated properties are tabulated in Table 53, which includes the pressures and enthalpies for saturated vapor and liquid.

If a Mollier diagram for a given hydrocarbon mixture is desired, and no PVT data on the mixture are available, the recommended method of preparing the chart is to use partial enthalpies, if available, or to use the ideal gas state enthalpies and the pseudo-critical with generalized correlations.

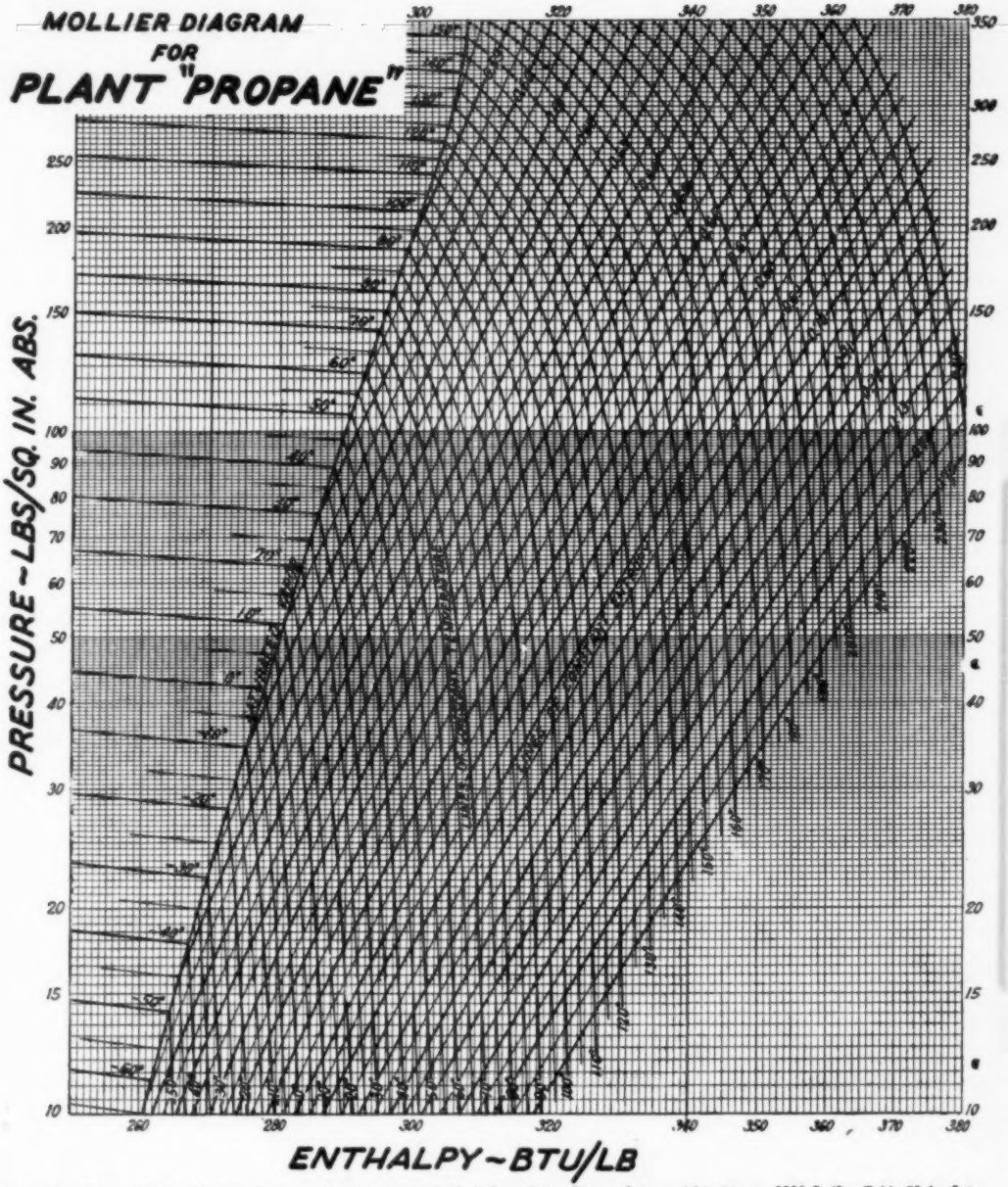


Figure 59—Mixture Mollier Chart to Illustrate Approximate Method of Compilation Datum: Saturated Liquid at —200° F. (See Table 53 for Saturated Liquid Enthalpy. See Text for Composition). Source: Laverty and Edmister.[2]

Comparisons of Methods

In Table 54 are results of some calculations made to show the differences between values of the isothermal effect of pressure found by four different approximate methods of three assumed mixtures. This comparison shows the differences in the methods only. The pseudo-critical method is believed to be the closest to the correct value. The Scheibel-Jenny nomograph results are close to the pseudo-critical results while the others are far off.

The generalized correlation for the isothermal effect of pressure on enthalpy presented as Figure 48 in Part XVI was used in the first two calculations. For the first, Figure 48 was applied to the entire mixture at once by the pseudo-critical. In the second calculation, Figure 48 was applied to each component individually to obtain ΔH_1, the pressure correction for each component. Values of ΔH_1 were com-

TABLE 53

Approximate Values of Saturated Liquid and Vapor Enthalpies for Hydrocarbon Mixtures for Use With Figures 58, 59, 60 and 61 (as indicated)

Units of Enthalpy-Btu./lb. above saturated liquid at —200° F.

	PROPANE-BUTANE MIXTURE (Refer to Figure 61)				PLANT PROPANE (Refer to Figure 59)				ETHANE-BUTANE MIXTURE (Refer to Figure 58)				PROPANE-PROPYLENE MIXTURE (Refer to Figure 60)				
	Sat. Liquid		Sat. Vapor		Sat. Liquid		Sat. Vapor		Sat. Liquid		Sat. Vapor		Sat. Liquid		Sat. Vapor		
Tem. °F.	Psia.	Enthalpy	Psia.	Enthalpy	Psia.	Enthalpy	Psia.	Enthalpy	Psia.	Enthalpy	Psia.	Enthalpy	Psia.	Enthalpy	Psia.	Enthalpy	°F.
—100									25.0	52.0							—100
— 95									28.0	54.0							— 95
— 90									31.8	56.8							— 90
— 85									36.0	59.5							— 85
— 80					13.6	63.5			40.0	62.0							— 80
— 75					15.0	66.0			45.2	65.0							— 75
— 70					16.5	68.4			49.8	67.5							— 70
— 65					18.3	71.0	10.0	260.5	55.5	70.5							— 65
— 60					20.1	73.6	11.2	262.0	61.5	73.0							— 60
— 55					22.1	76.0	12.5	263.0	67.3	75.5							— 55
— 50					24.5	79.0	14.1	264.3	74.0	78.5	10.3	270.0	13.4	79.3	13.3	264.0	— 50
— 45					27.0	81.7	15.9	265.9	81.5	81.0	11.9	271.7	15.3	82.2	15.1	265.5	— 45
— 40	5.3	80.0			29.5	84.2	17.8	267.0	88.5	83.6	13.5	273.0	17.1	85.0	16.9	266.9	— 40
— 35	6.0	82.3			32.5	87.0	20.0	268.5	97.0	86.2	15.5	274.5	19.1	87.3	19.0	268.2	— 35
— 30	6.8	84.7	4.1	263.5	35.6	90.0	22.5	269.8	103.0	89.0	17.5	276.0	21.6	90.0	21.30	269.7	— 30
— 25	7.7	87.3	4.6	265.0	39.0	92.6	25.0	271.1	115.0	91.8	20.0	277.3	24.1	92.9	23.7	271.0	— 25
— 20	8.74	90.0	5.3	267.0	43.0	95.5	28.0	272.8	125.0	94.0	23.0	278.0	26.9	95.5	26.5	272.7	— 20
— 15	9.74	92.3	6.0	269.0	47.2	98.5	31.0	274.0	137.0	97.0	26.0	280.0	30.0	98.1	29.5	274.0	— 15
— 10	10.8	94.6	6.8	271.0	52.8	101.8	34.5	275.4	149.0	100.0	29.5	281.6	33.2	101.0	32.9	275.6	— 10
— 5	12.2	97.5	7.7	273.0	56.5	104.0	38.1	276.8	161.0	102.5	33.4	283.0	36.6	103.5	36.4	277.0	— 5
0	13.5	100.0	8.8	275.0	61.0	106.2	42.0	278.0	175.0	105.5	37.6	284.2	40.5	106.4	40.0	278.3	0
5	15.0	102.3	9.8	276.5	66.8	109.0	47.0	279.5	190.0	108.5	42.3	285.8	44.3	109.0	43.8	279.6	5
10	16.6	105.0	11.1	278.5	72.6	111.9	52.0	280.9	204.0	111.2	47.5	287.1	48.5	111.5	48.0	281.0	10
15	18.4	107.6	12.4	280.0	79.0	114.5	57.5	282.0	220.0	114.5	53.2	288.7	53.0	114.2	52.9	282.3	15
20	20.2	110.0	13.7	282.0	85.5	117.2	63.5	283.4	236.0	117.5	59.8	290.0	58.0	117.0	57.8	283.7	20
25	22.5	113.0	15.5	284.0	92.4	119.9	69.3	284.6	254.0	120.5	66.6	291.2	64.0	120.0	63.4	285.0	25
30	24.8	115.6	17.2	285.5	100.0	122.6	76.0	285.8	270.0	123.5	74.4	292.5	70.0	123.0	69.0	286.3	30
35	27.1	118.0	19.2	287.0	108.0	125.5	82.8	287.0	290.0	126.8	82.0	294.0	76.0	125.5	75.0	287.7	35
40	30.0	121.0	21.1	288.8	116.0	128.2	88.8	288.0	310.0	130.0	90.5	295.0	82.0	128.3	81.7	289.0	40
45	32.3	123.0	23.5	290.2	125.0	131.0	97.0	289.0	330.0	133.2	99.5	296.5	89.0	131.4	88.6	290.1	45
50	35.5	126.0	26.0	292.0	134.0	134.2	106.0	290.3	350.0	137.0	110.0	298.0	96.0	134.0	95.5	291.1	50
55	39.0	129.0	28.6	293.3	144.0	137.5	114.0	291.3	370.0	140.5	122.5	299.3	104.0	137.3	103.0	292.5	55
60	42.5	131.7	31.5	295.0	153.0	140.5	122.0	292.5	390.0	144.2	135.0	300.6	112.0	140.0	111.0	293.7	60
65	46.0	134.1	34.8	296.8	164.0	144.0	131.0	293.5	412.0	148.5	146.0	301.9	120.0	143.0	119.0	294.8	65
70	50.0	137.0	38.0	298.0	174.0	147.0	141.0	294.5	435.0	153.3	160.0	303.0	129.0	146.6	128.0	296.0	70
75	54.2	140.0	41.0	299.8	185.0	150.3	150.0	295.5	458.0	158.2	175.0	304.5	138.0	150.0	136.0	297.0	75
80	59.0	142.7	45.0	301.4	195.0	153.7	160.0	296.4	480.0	164.0	190.0	306.0	149.0	153.5	146.0	298.0	80
85	64.0	145.5	48.5	303.0	209.0	157.8	171.0	297.5	502.0	172.0	210.0	307.3	159.0	156.8	158.0	299.0	85
90	68.3	148.0	52.1	304.5	222.0	161.7	185.0	298.5	..	..	229.0	309.0	170.0	160.5	169.0	300.0	90
95	73.0	150.5	56.9	306.2	235.0	165.5	197.0	299.5	..	..	..	..	..	..	..	..	95
100	78.0	154.0	61.0	308.0	250.0	170.0	210.0	300.5	..	..	270.0	312.0	..	..	..	..	100
105	84.3	156.5	66.0	309.5	265.0	174.6	222.0	301.2	..	..	..	..	..	..	..	..	105
110	90.0	159.2	71.0	311.0	280.0	179.0	239.0	302.2	..	..	319.0	314.0	..	..	..	..	110
115	97.0	162.5	76.0	312.5	298.0	184.0	251.0	303.0	..	..	..	..	..	..	..	..	115
120	104.0	165.8	81.5	314.0	315.0	189.0	267.0	304.0	..	..	370.0	316.2	..	..	..	..	120
125	111.0	168.5	87.0	315.5	..	..	..	..	..	..	..	..	..	..	..	..	125
130	118.0	171.5	93.5	316.9	..	..	309.0	305.0	..	..	..	..	..	..	..	..	130
135	125.0	174.0	100.0	318.3	..	..	..	..	..	..	..	..	..	..	..	..	135
140	134.0	177.5	107.0	320.0	..	..	326.0	306.0	..	..	..	..	..	..	..	..	140
145	144.0	181.5	115.0	321.2	..	..	..	..	..	..	..	..	..	..	..	..	145
150	153.0	184.7	122.5	322.6	..	..	..	..	..	..	..	..	..	..	..	..	150
155	163.0	188.0	130.0	324.0	..	..	..	..	..	..	..	..	..	..	..	..	155
160	172.0	191.5	140.0	325.0	..	..	..	..	..	..	..	..	..	..	..	..	160
165	184.0	195.0	148.0	326.0	..	..	..	..	..	..	..	..	..	..	..	..	165
170	195.0	200.0	157.5	327.0	..	..	..	..	..	..	..	..	..	..	..	..	170
180			176.0	329.0	..	..	..	..	..	..	..	..	..	..	..	..	180
190			200.0	330.3	..	..	..	..	..	..	..	..	..	..	..	..	190
200			225.0	331.3	..	..	..	..	..	..	..	..	..	..	..	..	200

bined with the results shown in Table 54. The difference is a very rough approximation of the heat of mixing, which is high in the critical region.

The "Figure 56 Av. Mol. Wt." values were obtained by taking differences in readings from the two parameters in Figure 56. These values agree fairly well for mixture A but not for the others.

The Scheibel-Jenny average molecular weight nomograph values were obtained by making readings at the initial and final conditions from the nomograph and subtracting.

Conclusions

The best approximation method for computing thermodynamic properties of hydrocarbon mixtures is to compute the effect of temperature by the summation of the ideal gas state properties and to find the effect of pressure by the generalized correlations, applied to the entire mixture by means of the pseudo-critical for the mixture.

TABLE 54

Comparison of Isothermal Effect of Pressure on Enthalpy of Hydrocarbon Mixtures by Four Approximation Methods.

MIXTURE:	A	B	C
Composition Mol fraction			
Methane	0.30	0.10	0.10
Ethylene	0.25	0.25	0.15
Ethane	0.20	0.30	0.20
Propylene	0.15	0.25	0.25
Propane	0.10	0.10	0.30
	1.00	1.00	1.00
Average Properties			
Pseudo-Critical T R	504	558	585
Pseudo-Critical Psia	693	666	673
Molecular Weight	28.5	32.5	34.5
[0psia 1000 psia] [Btu H — H] [lb. 200 °F. 200 °F.] [Mol]			
Pseudo-Critical and Fig. 48	1060	1555	2350
$\Sigma x_i \Delta H_i$ also Fig. 48	2121	2746	3698
Av. Mol Wt. Figure 56	940	1225	1310
Av. Mol. Wt. Nomograph of Scheibel-Jenny[3]	1200	1950	2550

If heats of mixing or the changes in the partial enthalpy on mixing are desired, these may be estimated by making two generalized evaluations with pseudo-criticals and comparing with the summation of the pure component enthalpy changes.

For the solution of light hydrocarbons in liquids, it is necessary to include in the generalized computation the latent heat of vaporization of the mixture in going from ideal gas vapor to liquid.

These generalized mixture methods are only approximations and their limitations should be recognized.

REFERENCES

[1] Brown, G. G., "A Series of Enthalpy-Entropy Charts for Natural Gases," Amer. Inst. of Mining & Metallurgical Eng. Tech. Publ. No. 1747 (1944).

[2] Edmister, W. C. and Pollock, D. H., "Enthalpies of Hydrocarbon Mixtures." Prepared at Whiting Research Laboratory of Standard Oil Company (Indiana) for Presentation at the Spring 1938 Meeting of Amer. Chem. So...

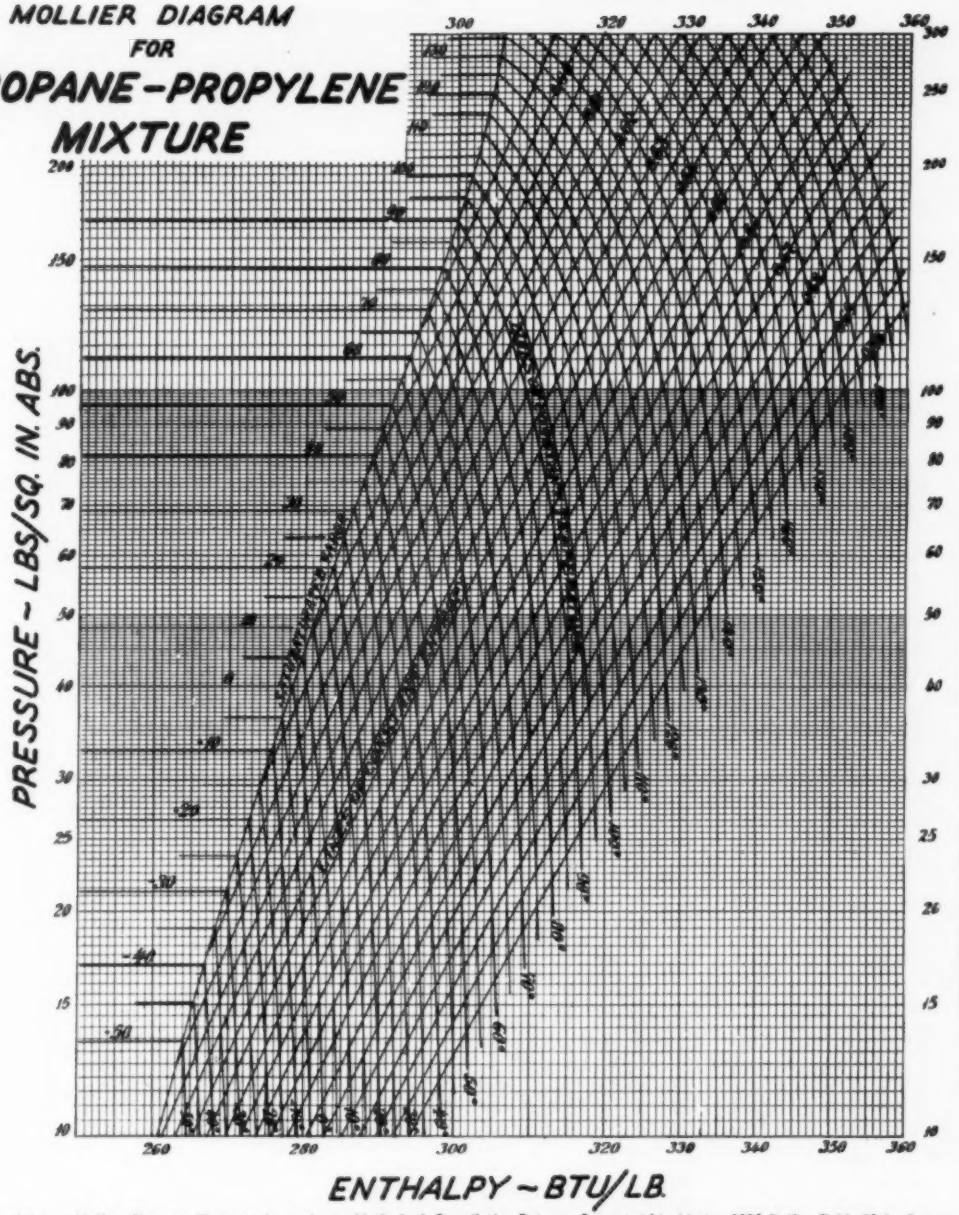


Figure 60—Mixture Mollier Chart to Illustrate Approximate Method of Compilation Datuum: Saturated Liquid at —200° F. (See Table 53 for Saturated Liquid Enthalpy. See Text for Composition). Source: Laverty and Edmister.[1]

in Dallas. Not released by Company.

[3] Laverty, F. W. and Edmister, W. C., "Liquefaction and Regasification of Lighter Hydrocarbons," Oil and Gas Journal, September 4, 1941 (page 35).

[4] Ragatz, E. G., McCartney, E. R. and Haylett, R. E., "Pressure-Temperature and Low Pressure Total Heat Relationships of Petroleum Fractions," Ind. & Eng. Chem. Vol. 25, 975 (1933).

[5] Rohman, A. and Krappe, J. M., "Properties of Butane-Propane Mixtures," Part 2 Chapter 2 of "Handbook-Butane-Propane Gases," 3rd Edition, Western Business Papers, Inc., Los Angeles (1942).

[6] Rossini, F. D., Pitzer, K. S., Taylor, W. J., et al, "Selected Values of Properties of Hydrocarbons," Circular No. C-461, U. S. Nat'l. Bureau of Standards (1945).

[7] Sage, B. H. and Lacey, W. N., "The Prediction of the Properties of Hydrocarbons at Elevated Pressures," 22nd Annual Meeting of Am. Petroleum Inst., San Francisco, Nov. 7, 1941.

[8] Sage, B. H., Olds, R. H. and Lacey, W. N., "The Enthalpy of Gaseous Hydrocarbon Mixtures," A.P.I. Research Project 37; Twenty-third Annual Meeting, Chicago, November 8, 1942.

[9] Sage, B. H. and Olds, R. H., "Application of Thermodynamics to Multicomponent Systems," Ind. Eng. Chem. 34, 526 (1942).

[10] Sage, B. H., Olds, R. H. and Lacey, W. N., "Tentative Partial Enthalpies of the Lighter Hydrocarbons," California Oil World 2nd Issue, November, 1946.

[11] Sage, B. H., Olds, R. H. and Lacey, W. N., "Two Gaseous Mixtures Containing Hydrogen and Nitrogen," Ind. & Eng. Chem. Vol. 40, 1953 (1948).

[12] Schethel, E. G., and Jenny, F. J., "Nomo-

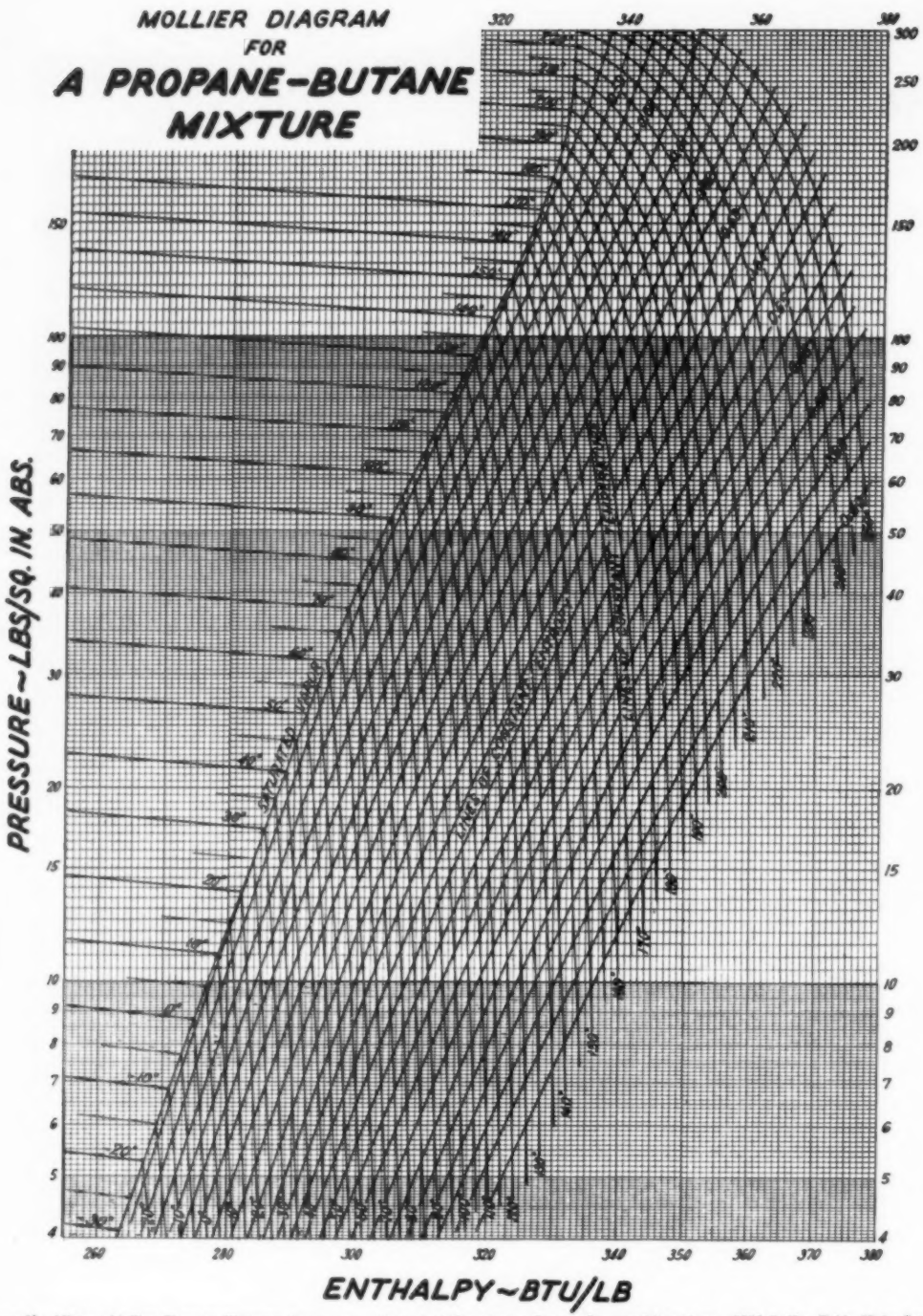
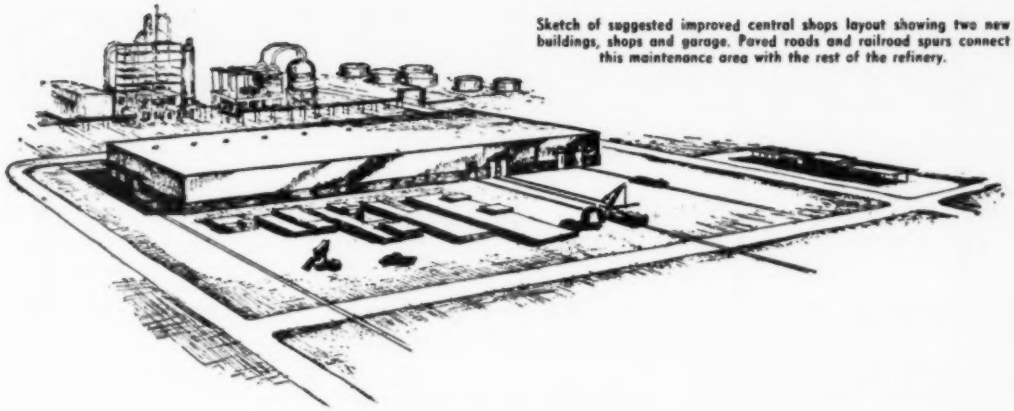


Figure 61—Mixture Mollier Chart to Illustrate Approximate Method of Compilation Datum: Saturated Liquid at —200° F. (See Table 53 for Saturated Liquid Enthalpy. See Text for Composition). Source: Laverty and Edmister.[3]

graphs for Enthalpies of Pure Hydrocarbons and their Mixtures," Ind. Eng. Chem. 37, 998 (1945).

[10] Scheibel, E. G., "Simplified Charts for Petroleum Process Calculations," Petroleum Refiner 26, 116 (March, 1947).

End of Part XVIII. Part XIX will appear in the May issue.



Sketch of suggested improved central shops layout showing two new buildings, shops and garage. Paved roads and railroad spurs connect this maintenance area with the rest of the refinery.

Maintenance Shops—

The Layout and the Tooling

DITMAS BROMLEY and HENRY P. EVANS
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THE LAYOUT in nearly all refineries follows one pattern, viz, poor tooling and disorder.

Poor tooling means a serious lack of handling facilities — very often, none at all. Men work with their bare hands; items are handled and rehandled; old, wornout machine tools are inaccurate and slow.

By disorder is meant that craft shops are in many small buildings scattered throughout the plant. Stores are in many places, also widely scattered.

Such conditions do not prevail where operators are concerned, process units generally being equipped to cut down operating labor and to improve effectiveness. Automatic controls, fine instrumentation, and good buildings usually are found.

Neglect or oversight, however, forces maintenance to work with makeshift things. Management has overlooked the dollars wasted, maintenance leaders have not presented their case properly to management. As a result, maintenance gets the leftovers, if any, after process gets the meat.

This paper would present a case for maintenance and then it would develop principles for the proper layout and proper tooling of maintenance shops. These principles form a foundation on which a refinery can build an up-to-date, effective maintenance department —a department that works fast and economically; a department that keeps units onstream longer; a department that shortens turnaround time to a minimum.

The maintenance shops in the usual refinery invariably are in many small buildings—buildings not designed to house shops; buildings scattered throughout the refinery.

The scattered buildings usually have no planned arrangement. And when there are several shops in one building, they're partitioned off. Thus, in effect, they too are separate buildings. This separating and scattering of shops slows down the flow of work. And it takes a lot of handling to maintain even this slow flow.

Seldom it is that one craft, working alone, can complete a routine job. Often the whole job, or its parts, must go from the unit to cleaning, to weld shop; thence to machine shop; and, finally, back to the unit or into storage. The usual refinery does not have the proper facilities for any of this frequent handling.

The machine tools are not modern, many have worked 20 years or more, they're obsolete and worn out. But they are not retired. Instead these machine tools struggle away at jobs that have grown far beyond their reach. The machinist, the mechanic, the welder, and other crafts waste hours with them, scheming special devices to handle a job that is far beyond the capacity of the machine.

Based on a dollar value, maintenance is the biggest user of stores in

***THE REFINERY** maintenance labor bill is needlessly high in many plants. According to the authors of this article, approximately one-half of all wage employes in typical plants are engaged in maintenance activities. Faulty layout of plant buildings and process equipment with regard to maintenance needs, lack of adequate materials handling facilities, scattered maintenance craft shops, obsolete and undersized machine tools, inefficient stores systems, and the use of man power where machines could be used, all contribute to an extremely expensive situation that is all too easily overlooked in large scale plant operations.*

The authors state two objectives. They first develop the case for maintenance and then outline principles for the proper layout and proper tooling of maintenance shops.

This discussion given early in April before a Group Session on Refinery Maintenance during the Mid-Year Meeting of the American Petroleum Institute's Division of Refining, in Houston.

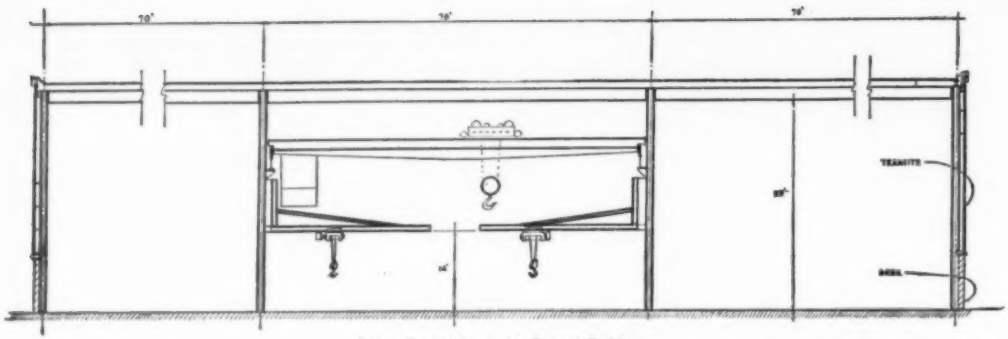

Figure 1—Inside of the Central Building.

the refinery, using about 35 per cent of the total. Thus maintenance has a vital interest in refinery stores.

The usual stores are scattered all over the refinery: in open areas, in hand-me-down sheds, in abandoned units, in the tank farm—in fact, any place where the storekeeper can find room to set them down.

Incoming stores must be unloaded, sorted, classified, and laid away in an orderly fashion. Later they must be found, dug out, and delivered. This all adds up to a lot of handling. To do this handling the storekeeper has a few hand trucks, some rollers, and men by the score. This is not right.

Scores of other things are vital to maintenance besides the shops and the stores. There must be tools for handling the apparatus as a unit. There must be proper tools for hauling, from unit to shop and back again. These tools include built-in air hoists, fork-lift trucks, cranes, and handling equipment of all sorts; trucks and trailers; and, finally, good roads.

In the usual refinery, if we find anything at all for this handling and hauling, it is a trolley hung on a monorail. But no hoist—that's probably in storage. If we look for fork-lift trucks, we find none. When we do find a crane, it's usually too small or worn out and, therefore, seldom used. Then we usually find a few old, light trucks creeping along on roads that are narrow, twisted, and unpaved.

The Result of These Wrongs

What is the result of these wrongs? The cost books show that, of all the wage people, one-half are working on maintenance. A refinery charging 30,000 barrels per day will have some 1,200 wage employees, and 600 of them will be working on maintenance. When we add in the so-called overhead, this maintenance labor cost amounts to some $6000 a year per man or $3 million a year for the 600.

Other money also is going down the drain. Units are offstream longer than they need be, because both turnarounds and emergency repairs are too slow. This extra downtime costs real money, too. For an 30,000-barrel refinery, each day of downtime cuts net income by $60,000 or more.

The Principles

Those experienced in construction and maintenance in refineries and in other industries have developed certain principles and if these principles are properly applied savings are enormous. For they are the principles that rid refinery maintenance of poor tools, disorder, and high costs.

Centralize the facilities! Bring together, into one central area, all of the facilities that properly belong together: craft shops; headquarters for field crafts; stores; cleaning facilities; garage; offices. This centralizing reduces and simplifies the handling, improves supervision, and avoids duplication.

Combine the buildings! Put into one building all of the craft shops, all inside stores, and the cleaning facilities because 1) A single building costs less than several smaller buildings, both in first cost and in maintenance. 2) A single building gives greater flexibility in allotting floor space to meet ever-changing needs. 3) The common use of handling facilities by all activities makes for economy. 4) A central building gives closer coordination between all the activities, promotes cooperation among the crafts.

Tool the men! Man's horsepower is puny compared with that of a machine. A 1-horse motor can do the work of 30 men. For 8 hours of work, the motor costs 10 cents. For the same work, the men cost $700. Machines can beat men 7000 to 1 so provide machines wherever possible to do the physical work of men. And provide plenty of small power tools to help a man do his hand work. This principle applies to all men: laborers, helpers, office workers, craftsmen, supervisors and superintendents.

Better Handling and Access

Tool the unit! Add facilities to a unit to provide better handling and better access. Many heavy things such as column trays, tube bundles, pumps and valves should always be handled by mechanical means—by power hoists, gantries, or by mobile equipment such as cranes and fork lifts. Get rid of makeshift things that must be brought to the job each time—makeshift things that call for an excess of manual labor, such as rollers, skids, and cribbing. But handling equipment alone is not enough. Men must be able to get at things—quickly and easily. Platforms, stairways, and ladders that are always at the unit make access easy. And they get rid of temporary scaffolding.

Tool for hauling! Good vehicles, moving on straight paved roads, shrink the size of any refinery. Well-built roads reduce the wear and tear on mobile equipment. And they prevent costly delays in hauling during bad weather.

Train the men! To be sure that these new tools and new methods will work properly, maintenance must cast off its traditional ways—once and for all. Supervisors must be trained to use the new tools as they should be used. The training must reach out to the craftsmen, and to all maintenance workers.

Keep flexible! This is mighty important in maintenance. New methods, new tools, new processes, changing labor relations, changing work load—all of these make for ever-changing conditions; conditions that must be met by re-arrangement of machine tools, by expanding the work areas, by enlarging the buildings. Now to apply these principles as a new layout for maintenance is made.

All of these principles apply to any

refinery, regardless of its size. But to make their application more concrete, choose an average refinery and see how the principles work out.

This average refinery has a daily throughput of 80,000 barrels of crude. The units take up some 150 acres, and the tankage spreads over perhaps 200 more. The units are the usual ones: crude and rerun stills, topping units, light-ends recovery, cracking units—both thermal and catalytic, polymerization units, an asphalt plant, and a lube-oil plant. Then there are the utilities. Today, in this average refinery, there are some 600 wage men working on maintenance.

What needs centralizing? There are the usual 12 craft shops: machine, weld, pipe, boiler, electric, instrument, carpenter, valve sheet metal, blacksmith tank-car repair and paint. And with these, include the tool rooms.

Then there are field crafts, that work out of headquarters, other than their own craft shop. These include laborers, insulators, and riggers. And let's not forget the stores—those in various buildings, and those in the many outdoor areas.

There are the facilities for cleaning tube bundles, pumps, valves, etc. The garage maintains the mobile equipment for maintenance, and for the rest of the refinery. Then there are the offices for the maintenance staff—general supervisors, foremen, and clerical workers.

All of the craft shops can go together in one building. None works by itself or must be kept apart for reasons of safety. So, put them all together with no partitions to interfere with the flow of work from one shop to another. Then gather up all that shop work now done at the units or in the field, and put this work where it belongs—in the craft shops.

Room for Field Crafts

Field crafts need but little shop space, but they do need room for tools and a place to headquarter. All of the field crafts—except the laborers, insulators, and riggers—work closely with their own shop craft. Thus most of the field crafts should headquarter and keep tools in their corresponding shops—a good combination! Laborers, insulators, and riggers should be given headquarters and tool space in the same building as the craft shops.

The things that should store inside should be put together in a single building and the things that should store outside in one area adjoining that building. There's no reason to separate stores from shops. But there are several good reasons to combine them.

Most of the stores are used by maintenance, and a goodly quantity of the stores go directly into the shops. By combining shops with stores, the handling facilities serve both. Thus the amount of handling is not only reduced but we speed it up.

As for the cleaning facilities, put them together in one cleaning area in the central building.

The garage in the average refinery gives the mobile equipment the same complete service that a retail service station gives to the traveling public—washing, lubricating, fueling, and minor repairs. But it does not make major overhauls. Inasmuch as a garage like this needs no special machine tools nor many stores, it should be in a building of its own.

As to offices this average refinery has for the crafts, both shop and field, an office for each foreman and several offices for clerks. In stores, there are offices for the storekeeper and about 10 other people. In the garage, there are two offices—one for the foreman and one for the dispatcher. Then there are offices for the supervisory staff. Altogether, there are 35 people who need offices.

Where shall these offices be located? The two offices for the garage should be in the garage building. And the eleven offices for the stores should be in the stores section of the central building with the remaining 22 offices in the shop section.

The Size

But how do we get the size of these things? To size the shop section of the central building, each shop must be laid out. Before this can be done, needed machine tools must be listed. Such a list comes only from a detailed study of the work in the refinery, but it can be said that machine tools should be new, up-to-date, and fast-working. And they should be able to handle all the mechanical work that comes to maintenance.

Assume now that the list has been made up. On it are many of the machine tools found in almost any refinery. But on it are some other machine tools that are usually missing from refinery shops, these including horizontal boring mills, vertical boring mills, metal-cutting band saws,

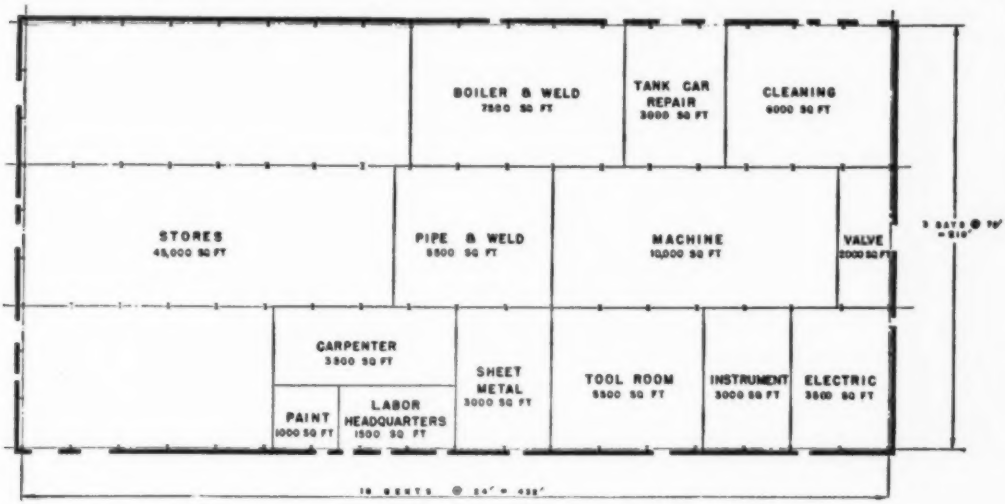

Figure 2—Arrangement of the shops. Depth is 210 feet—three bays, each 70 feet.

abrasive cut-off saws, balancing machines, cold benders for pipe, torch-cutting machines for plate, hydraulic press brake, plate rolls, assembly jigs for tube bundles, and paint spray booth.

The layout of the tools changes radically as various clear distances between building columns are used. The best layout comes with a column spacing of some 70 feet which affords a clear aisle through each bay—with machine tools ranged along both sides of the aisle. Each machine tool has ample working space around it. Breakdown-and-assembly areas are always available from the through aisles. These are the things that make a good shop layout.

The shop-section totals some 55,000 square feet of floor space. This includes everything: aisles, open areas, office space, and roadways. The areas in square feet of the craft shops are roughly as follows:

Craft Shop	Area
Machine	10,000
Pipe and weld	5,500
Boiler and weld	7,500
Electric	3,500
Instrument	3,000
Carpenter	3,500
Valve	2,000
Sheet metal	3,000
Tank-car repair	3,000
Paint	1,000
Cleaning	6,000
Central tool room	5,500
Headquarters for field crafts	1,500
Total	55,000

Size of Stores Operations

To get some idea of the size of the stores operation, look first at the inventory. Its dollar value is roughly $1.5 million in this average refinery, and it turns over twice a year. Thus the store business has an annual volume of $3 million. The total area for stores is going to be big.

The area needed for inside stores and for outside stores is best gauged by the size of the existing storage areas in the average refinery. But the sum of these areas must be reduced, because stores need less space when they are in the central building where modern methods can be used for handling and for stacking. Power lift trucks, pallets, and modern steel bins—all these things help to reduce the areas needed.

The tendency is for stores to keep too many things that are used seldom if ever. So be alert to this tendency, and separate the areas for junk from the areas for proper stores.

In looking at the areas for stores in the average refinery, notice what stores are in the open and decide if it is proper for these stores to be out in the weather.

Our experience in working over refinery stores reveals that the average refinery should have roughly 45,000 square feet for inside stores and some 50,000 square feet more for outside stores. These areas allow for offices, aisles, and roadways. Thus the central-building area is 55,000 square feet for shops, plus 45,000 square feet for inside stores—a total of 100,000 square feet. This area is ample for everything that goes into the central building.

Shops and stores fit nicely into three 70-foot bays. Thus the central building is roughly 210 feet wide by 440 feet long. See Figure 1. The building has a rigid frame, with each of the bays designed to take a bridge crane. The height from floor to crane rail is not less than 27 feet in any bay. The distance from the floor to the under side of the roof girders is then 35 feet.

Thirty jib cranes with air hoists are mounted on the building columns. These jibs can move loads up to one ton for short distances. The building has no unsightly saw teeth. It has no windows. Instead artificial lighting spreads the proper amount of light uniformly over the whole floor. The air is cooled in the summer, heated in the winter, and filtered at all times.

Arrangement of the Shops

The flow of work in a maintenance shop is not so easily planned as the flow of work in a manufacturing shop. But many of the ideas of production-line flow can be used. Machine tools in each shop can be arranged for progressive flow of the normal work. And craft shops that usually work together can be located in the same bay, and adjoining each other.

Figure 2 shows the arrangement. All of the light shops are in one outside bay of the three-bay building. Starting at the end wall of the building, one progresses through the light shops toward the stores area, in this order: electric, instrument, tool room, sheet metal, labor headquarters, paint and carpenter.

In the center bay, starting at the end wall and going again toward stores, there are several of the heavy shops, in this order: valve, machine, pipe and its welding section. The rest of the heavy shops are in the remaining outside bay. Taken in the same order, these shops are cleaning, tank-car repair, boiler and its welding section.

Arrangement of the Stores

One of the jobs of stores is to deliver materials to the shops, when needed, where needed and with the least handling. Thus are put inside stores used by the heavy shops in the same two bays as those shops. Stores used by the light shops go in the same bay as those shops. The aisles in the shop area continue straight on through the stores area. Fork lifts and utility trucks use these aisles to make quick deliveries. For heavy items, the bridge cranes can run directly from stores to the shops.

Keep Flexible

Our last principle is keep flexible! And this is important. Few maintenance groups will be doing the same work in the same way, day after day, year after year. Processes change. Men develop better machines and better techniques. Shop methods change. Labor relations change. What are the best ways of keeping flexible to meet these changes?

By remembering that we are meeting only the immediate need: Buildings will grow; outside areas will grow. The proper way to handle this growth is to provide for it now. The area on which to centralize today needs, say, 10 acres. Let's provide half again this much, say 15.

By designing buildings so they can grow easily in two directions—grow by adding a bay on one side or by extending one end: That means we must keep the design simple; use the same column spacing throughout the entire building; use one height throughout—no lean-tos or attached sheds; make each bay capable of taking a bridge crane; keep the floor at ground level throughout the building; keep out of the craft shops and the stores area any multi-story structures, any balconies, any mezzanine floors—in short, anything that may later hinder the growth of work areas or the rearrangement of tools and stores.

The New Result

Our average refinery now has two new buildings, viz: a central building; a garage building (see sketch on page 167). The area around these two buildings is large and well paved. Paved roads and railroad spurs connect the maintenance area to the rest of the refinery. The field crafts are using up-to-date mobile equipment. Shop crafts are busily at work on their modern machines. Stores men, with their new mobile equipment, are making quick deliveries. Morale is high. What about the bank account? Well, it's down—maybe by $3 million or more. For that's what management must spend to buy these things.

But management is not worried. Someone has convinced management that the payout is enormous—so enormous, in fact, that management's money will be back in less than five years.

Hydroforming and Thermal Reforming Operations on Sweet and Sour Heavy Straight-Run Naphthas

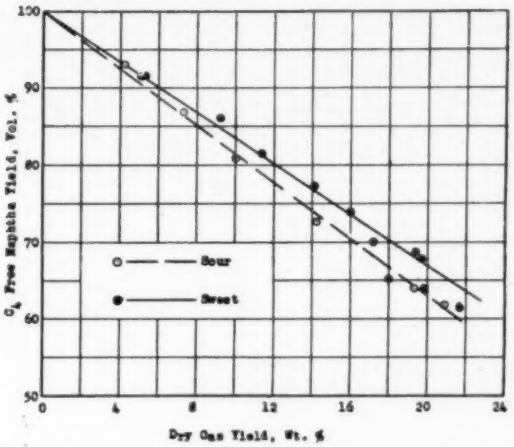

Figure 1. Thermal Reforming Operations—Debutanized Naphtha Yield vs. Dry Gas Yield.

N. H. McLAURIN, C. H. McINTOSH, and D. S. KAUFMAN

***THE EVALUATION** and proper choice of process routes which can be followed with a given feed stock are most important to refiners. If the most profitable operation is to be achieved, an optimum balance of investment, operating cost, and product market value must be reached. In this report, presented last month before the Western Petroleum Refiners Association during their annual meeting in San Antonio, the authors give detailed comparisons of results of hydroforming and of thermal reforming operations. Data obtained in runs on sweet and sour heavy straight run naphthas are presented. Product distributions and yield octane number relationships are compared. Relative economics of the two processes, on both feed stocks, are given.*

Here indeed is additional data that refiners generally may find helpful in evaluating the utility of these two processes in specific plant applications.

McLaurin and McIntosh are with The Texas Company, the former at Port Arthur, Texas, and the latter in New York. Kaufman resides in Houston.

HYDROFORMING operations on high-sulfur naphthas result in the production of hydroformates practically free of sulfur. Thermal reforming also reduces the sulfur content of high sulfur naphthas. Both processes result in a product of increased octane number. It was the purpose of this study to compare the results obtained by thermally reforming a high sulfur heavy straight run naphtha with the results obtained by hydroforming the same stock. A comparable study was also made on a low sulfur stock in order to provide a basic comparison in which sulfur reduction was not a factor.

The two charge stocks used in this investigation were heavy straight run naphthas from sweet and sour crudes. Pertinent tests on these stocks are presented in Table 1. The sour stock contained 0.421 percent sulfur, whereas the sweet stock contained only 0.008 percent sulfur. The clear octanes on these stocks are comparable, but the leaded octanes on the sour stock are much lower than those on the sweet stock, as would be expected. The sour stock was also of a slightly higher boiling range than the sweet stock.

Thermal Reforming Operations

A single pass, coil only, thermal reforming pilot unit was employed in the thermal reforming portion of this study. The total cracked product was stabilized in a brine cooled stabilizer so as to cut in the butane fraction and the reformate drawn off as stabilizer bottoms. The stabilized product was also used as quench at the cracking coil outlet in order to prevent transfer line cracking. The total reformate was steam stilled to the end point of the original charge using a gas oil as a "chaser" in order to obtain reasonably good fractionation.

A series of 18 runs was made on the thermal reforming unit. Eight runs were made charging heavy straight-run naphtha from the sour crude and ten runs charging heavy straight-run naphtha from the sweet crude. The majority of the thermal reforming runs were made at a heater outlet temperature of about 1050° F., with a few runs at slightly lower temperatures (990-1020° F.). Heater pressure was varied from 400 to 650 psig. The coking limit was determined on each stock. This was accomplished by increasing the severity of the reforming conditions slightly on each succeeding run until the unit coked, either in the heater or

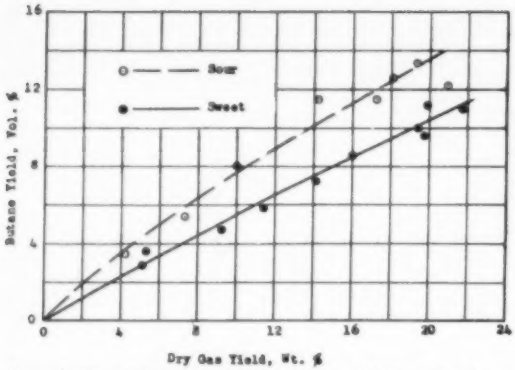

Figure 2. Thermal Reforming Operations—Butane Yield vs. Dry Gas Yield.

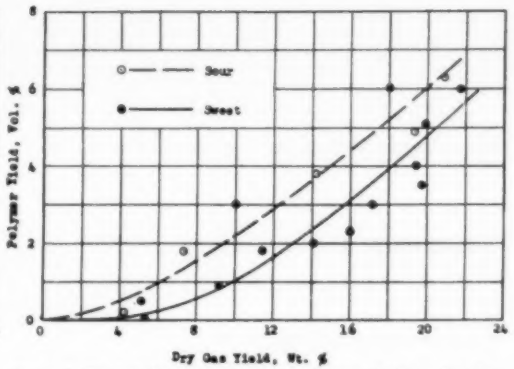

Figure 3. Thermal Reforming Operations—Polymer Yield vs. Dry Gas Yield.

at the heater pressure control valve. The cracking coil was then thoroughly decoked and operations again attempted at the same conditions at which the unit had cooked previously in order to verify the coking limit by means of a check run. If the unit did not coke on the check run, then it was assumed that the coking limit had not been reached, and succeeding runs were made at increasing severity until the coking limit was reached, as verified by a check run. An indication of the scope of operations is presented by the range of dry-gas propanes and lighter yields obtained on each stock:

	DRY GAS YIELD, WEIGHT PERCENT	
STOCK	Minimum	Maximum
Hvy. SR Naph. from		
Sour Crude	4.2	20.9
Sweet Crude	5.1	21.7

It will be noted that the coking limit on each stock was encountered at approximately the same dry-gas yield.

Hydroforming Operations

The pilot unit used for the hydroforming portion of this investigation was equipped with two reactors and regenerating equipment for continuous operation. The hydroformed product from the reactor was directed to a gas separator. The overhead gas from the separator passed to an absorber, from which the unabsorbed gases were recycled through a heater and the processing reactor. Use of this system resulted in keeping the concentration of heavy hydrocarbons (C_5 plus) in the recycle gas below 10 per cent in most cases. The absorbent and heavy hydrocarbons absorbed therein were charged to a stripper, where the heavy gaseous hydrocarbons were stripped off, combined with the liquid from the gas separator, and directed to a brine cooled stabilizer. The product was stabilized continuously, the separation being made in the butane fraction. Regeneration of the catalyst was accomplished by burning off the carbonaceous deposit with air, using neutral flue gas as an air carrier and cooling medium. The regeneration was down flow and the gases were not recycled. After regeneration the catalyst was reduced preparatory to processing by directing part of the hydrogen-rich recycle stream through the reactor. This pilot unit compares favorably in yield and product quality with several commercial hydroformers.

The catalyst employed in this study was a molybdena-alumina hydroforming catalyst in the form of $\frac{3}{8} \times \frac{3}{8}$ inch pellets. The stabilized total hydroformate from the unit was not fractionated to the endpoint of the original charge because of the small amount of polymer produced. The polymer yield was calculated from fractionation data on the charge and product.

Forty-four hydroforming runs were made under varying conditions as shown below:

	HEAVY SR NAPHTHA FROM	
CHARGE STOCK	Sour Crude	Sweet Crude
Number of Runs	21	23
Reactor Temperature, Avg. °F	896 to 961	878 to 965
Space Velocity, v/hr/v	0.5 to 2.0	0.5 to 3.0
Reactor Pressure, psig	80 to 254	50 to 254
Recycle Gas Rate, CF/bbl.	1300 to 3300	800 to 2800

In both the hydroforming and thermal reforming studies hydrocarbon analyses of the gaseous fractions were obtained by mass spectrometer, while the liquid samples were analyzed by low temperature fractional distillations. Yields direct from the units were adjusted to an output basis by proration among the products from the unit.

TABLE 1
Charge Stock Tests

	Heavy Straight Run Naphtha From:	
Charge Stock	Sour Crude	Sweet Crude
Tests:		
Gravity, °API	49.1	55.5
Sulfur, Lamp, Wt. Percent	0.121	0.008
Octane Numbers:		
ASTM Motor—Clear	41.7	43.0
+ 3 cc. tel/gal.	54.4	66.4
ASTM Research—		
Clear	40.8	42.2
+ 3 cc. tel gal.	52.7	68.8
ASTM DISTILLATION:		
IBP °F	222	172
10 percent °F	276	242
50 percent °F	322	280
90 percent °F	360	324
EP °F	392	362

Results

Although it is recognized that the product distribution of reforming is affected by variations in pressure, the effect, according to available correlations, is not very great over relatively small ranges and has been ignored in the correlations of thermal reforming results which follow since the range of pressures was not extensive. The same is true of the effect of pressure and hydrogen recycle rate on hydroforming and the correlation of these results.

1. Thermal Reforming Operations

The product distribution obtained when thermally reforming both the sweet and sour stocks is presented in Figures 1, 2, and 3. In these illustrations the yield of debutanized naphtha, butanes and polymer are shown as functions of dry gas yield. Basis constant dry gas yield, a slightly higher

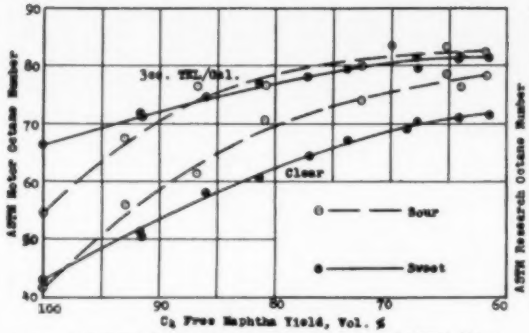

Figure 4. Thermal Reforming Operations—Variation of ASTM Motor Octane Number with Naphtha Yield.

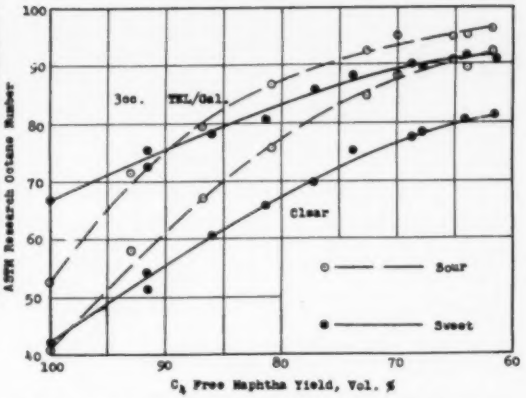

Figure 5. Thermal Reforming Operations—Variation of ASTM Research Octane Number with Naphtha Yield.

percentage of polymer and butanes were produced from the sour stock, while the yield of debutanized naphtha was slightly lower. This difference in product distribution is probably due to the difference in boiling range of the stocks. In Figure 4 the clear and leaded ASTM Motor[3] octane numbers are correlated with naphtha yield for operations on both the sweet and sour charge stocks. These correlations indicate that if stocks of essentially the same clear octane were processed, operations on the sour stocks would result in higher clear octane numbers over the entire operating range, and in a slightly higher leaded octane at the higher conversions. The variation of the ASTM Research[3] octane number with naphtha yield for both stocks is presented in Figure 5. The results are essentially the same as those presented in Figure 4 for the ASTM Motor octane numbers. The leaded octane number advantage for the sour stocks at high conversions is greater than was reflected by the ASTM Motor method.

A salient feature of this investigation is the conspicuous discrepancy which exists between the yield-octane number relationships obtained on the two stocks. Although the tests on the charge stocks indicate differences in boiling range and characterization factor, these differences are not large. Basis available data and previous experience, these differences are believed to be too small to account for an octane number difference of the magnitude found in this study. A possible reason for this discrepancy in the yield-octane relationships obtained on the two stocks is the difference in the sulfur contents of the feed stocks and the desulfurization of the sour stock upon processing. The extent of this desulfurization is shown in Figure 6, in which the naphtha sulfur content is correlated against naphtha yield.

Comparison of the data obtained in this study with established thermal reforming correlations indicated that:

(1) The yield distribution obtained in the subject study was, in general, in fair agreement with that predicted from existing thermal reforming correlations.

(2) The octane improvement obtained when reforming the sweet stock was in good agreement with that predicted from the correlations, while operations on the sour stock resulted in a much higher improvement than would have been predicted.

2. Hydroforming Operations

The resultant product distribution from hydroforming operations on the two stocks is presented in Figures 7, 8, and 9. As was done in the case of the thermal reforming, the yields of the various products are presented as functions of the dry-gas yield. The effect of the difference in the feed stocks is indicated to be essentially the same as was observed for the thermal operations. In Figure 10, the ASTM Motor octane number is correlated with naphtha yield for operations on both stocks. These results indicate that when hydroforming two such stocks of essentially equal clear octane number, a clear octane number advantage is obtained by processing the sour stocks. A leaded octane number advantage is also shown for the sour stock at high conversion levels. Figure 11 presents the correlation of ASTM Research octane number with naphtha yield. The indicated comparative results are virtually the same as for the case of the ASTM Motor octane number-yield relationships.

As discussed under the section on thermal reforming operations, the octane number superiority of the reformate from the sour charge is possibly attributable to the desulfurization of this stock. The sulfur content of the hydroformate was almost con-

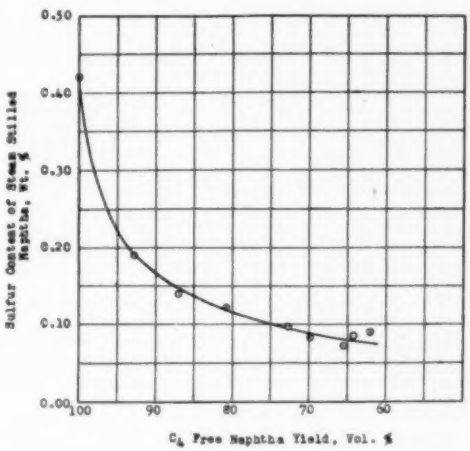

Figure 6. Thermal Reforming Operations—Variation of Naphtha Sulfur Content with Yield.

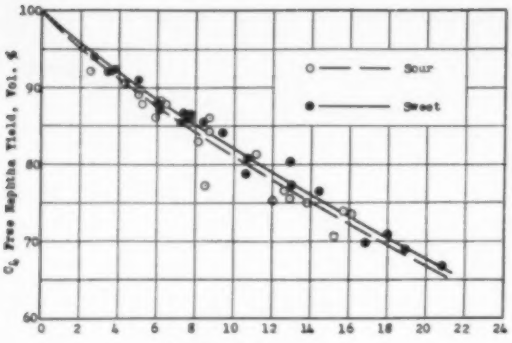

Figure 7. Hydroforming Operations—Naphtha Yield vs. Dry Gas Yield.

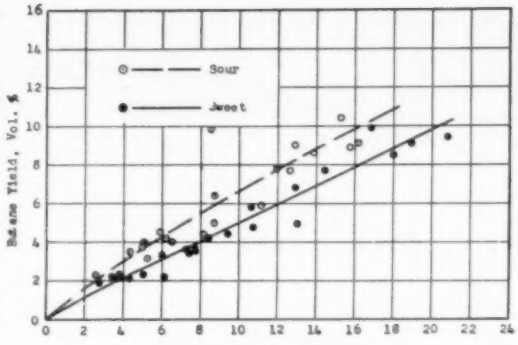

Figure 8. Hydroforming Operations—Butane Yield vs. Dry Gas Yield.

stant at about 0.005 wt. % over the entire conversion range. This contrasts markedly with the thermal reforming desulfurization, where the sulfur content of the reformate varied with conversion.

Comparison of Hydroforming and Thermal Reforming Yield—Octane Number Relationships

A comparison of the hydroforming and thermal reforming processes on a yield-octane number basis may be made by evaluation of Figures 4, 5, 10, and 11. In each case hydroforming is indicated to possess a definite yield-octane number advantage over thermal reforming over the entire range of operations covered by these data.

Economic Comparison

In order to evaluate these processes further, an economic comparison was made. This study was based on the production from both sweet and sour crudes of a constant quantity of leaded base stock at various octane levels (+ 3 cc. tel./gel.). The raw base stocks were considered to be composed of thermally cracked naphtha and light and heavy straight run naphthas, in the ratio of their production from cracking and crude stilling operations. The total base stocks were upgraded to the desired octane level (at 3 cc. tel./gel.) by thermal reforming and hydroforming of a portion of the heavy straight-run fractions. Naturally, in a procedure of this sort there are various alternative combinations of percentage heavy naphtha reformed and depth of reforming which will result in the same octane level of the total base stock after blending back the reformate. In making this study the most economical combination of the above variables was used in each instance. The raw-base stock was assumed to be available at a constant cost and in sufficient quantity to result in the production of a constant quantity of improved base stock. The relative economics of hydroforming and thermal reforming were compared, basis the relative costs of the final leaded blends after allowing credits for the by-products from the processing operations. Actual plant operating costs for hydroforming and thermal reforming operations were employed in making the comparison. Investment costs were not included.

Figure 12 presents the economic comparison of the two processes at constant lead concentration of 3 cc. tel./gal. In this figure the cost of the upgraded base stock (expressed as a cost index, using the cost of upgrading the base stock to 74 ASTM Motor octane number by thermally reforming the sour stock as a base) is correlated with the ASTM Motor octane number level for processing both the sweet and sour stocks. Over most of the octane number range, thermal reforming is indicated to be slightly cheaper than hydroforming. At the higher octane range (above 77.4 on sweet stock and 78.3 on sour stock), however, the cost of hydroforming appears slightly less. The differences in each case are small and are not considered significant. It is interesting to note that essentially the same results are indicated when comparing the two processes on either the sweet or the sour stock. Inasmuch

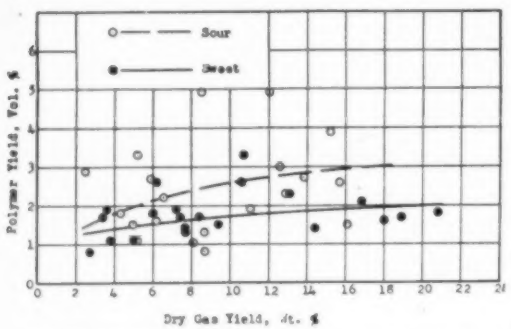

Figure 9. Hydroforming Operations—Polymer Yield vs. Dry Gas Yield.

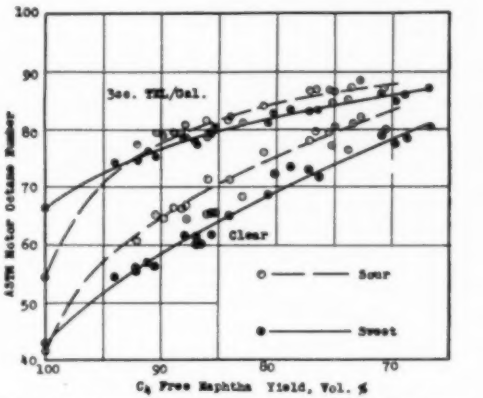

Figure 10. Hydroforming Operations—Variation of ASTM Motor Octane Number with Naphtha Yield.

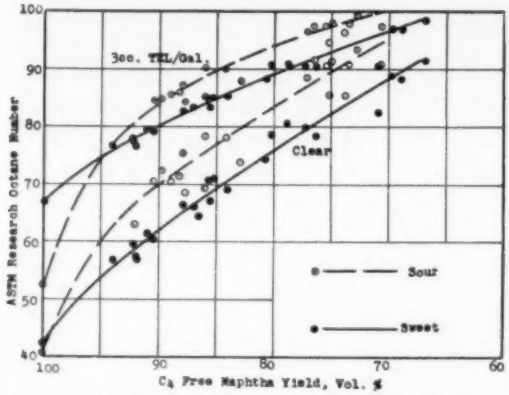

Figure 11. Hydroforming Operations—Variation of ASTM Research Octane Number with Naphtha Yield.

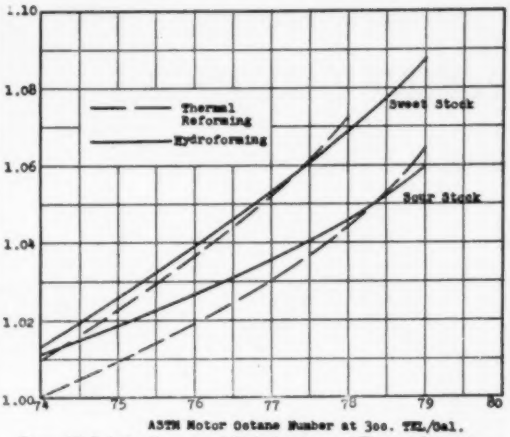

Figure 12. Relative Economy of Hydroforming and Thermal Reforming—Cost Index vs. Octane Level.

as this study was based only on the direct operating costs of the two processes, the higher investment cost of the hydroforming equipment would make the hydroforming process appear economically unattractive in this comparison. It should be stressed, however, that this conclusion may not be applicable to all refinery situations. A number of factors are involved, such as the product requirements of the individual plant, the level of operating costs, by-product values, etc. It is quite likely that in some instances the opposite conclusion may result from such a comparison.

Conclusions

The results of this investigation may be summarized as follows:

(1) Hydroforming was found to possess a definite yield-octane number advantage over thermal reforming.

(2) When reforming to a given octane number, thermal reforming was found to be more economical below about 78 ASTM Motor octane number and hydroforming more economical above that level. The differences between the two processes were small, however, and are not considered significant.

(3) Reforming of the sour stock was found to result in a much more attractive yield-octane number relationship than reforming operations on the sweet stock.

(4) The relative economics of the two processes were virtually the same for both the sweet and sour stocks.

ACKNOWLEDGMENTS

The authors wish to express their appreciation to J. M. Barron and A. R. VanderPloeg for their helpful suggestions.

BIBLIOGRAPHY

[1] D357-47 Standard Method of Test for Knock Characteristics of Motor Fuels by the Motor Method.

[2] D908-47 Tentative Method of Test for Knock Characteristics of Motor Fuels by the Research Method.

* * *

Attend Conference On Cracking

Representatives who attended the recent conference on cracking held at Sinclair Research Laboratories in Harvey, Ill., are from left to right: T. D. Tifft, assistant chief engineer, Sinclair Refining Company; W. V. Ischie, assistant superintendent, Sinclair Refining, East Chicago, Ill.; J. D. Siefer, assistant superintendent, Sinclair Refining, Houston; C. F. Mallory, assistant superintendent, Sinclair Refining, Corpus Christi, Texas; R. E. Howe, assistant superintendent, Sinclair Refining, Sinclair, Wyo.; F. W. Griscom, assistant superintendent, Sinclair Refining, Marcus Hook, Pa.; T. P. Kimball, technical assistant to the vice president in charge of manufacturing; E. C. Herthel, manager of research and development department, Sinclair Refining, Harvey, Ill.; L. F. Strader, assistant superintendent, Richfield Oil Corporation's Watson refinery, Los Angeles, Calif.; F. B. Bluhm, head of inspection department, Sinclair Refining; and O. F. Campbell, combustion engineer, Sinclair Refining.

REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the industry.

JOSEPH M. BARRON

HUBERT P. McREYNOLDS

Thermal Cracking Is Texaco Men's Topic

"THERMAL Cracking of Fluid Catalytic Cycle Gas Oils" by Joseph M. Barron and Hubert P. McReynolds of Texaco Development Company and The Texas Company, respectively, Port Arthur, Texas, begins on page 111 of this issue of PETROLEUM REFINER. This article is one of wide interest to technologists in the refining industry concerned with catalytic cracking and the products therefrom. It constitutes a report on thermal cracking research work in pilot plant and commercial equipment with gasoil feed stocks from catalytic cracking operations.

Joseph M. Barron was born in Huntsville in 1905. He traveled west as far as San Angelo, Texas, then doubled back to the booming refinery city of Port Arthur, arriving there at the ripe old age of 9 years. He was graduated from Port Arthur High School in 1922, and entered Rice Institute at Houston to study chemical engineering in September, 1923. After completing two years of his college work, Barron left Rice and went to work for Gulf Refining Company. Some four years later, in 1929, he returned to Rice to complete his studies for a degree in chemical engineering. He worked also for Gulf Production Company during his junior and senior years.

In 1931 Barron returned to Port Arthur and entered the employ of The Texas Company. His work for The Texas Company has centered on cracking research, his activities including cracking research in laboratory, pilot plants, and full-scale units. For a six-year period, through 1948, he was director of cracking research at Port Arthur. On the first of this year, he became local representative of Texaco Development Company, a position which presently occupies his full efforts. He is a member of ACS.

Barron and Mrs. Barron have two daughters, Beverly, 14, and Marilyn, 10. He reports that life at home is never dull.

Hubert P. McReynolds hails from the foothills of Arkansas northwest of Little Rock. His birthplace was Morrilton, in 1913. Tired of raising strawberries, he said, McReynolds went to Harding College where he earned a degree in chemistry in 1935. The year he was graduated he moved to Port Arthur to work for The Texas Company as an experimental operator in the cracking department research laboratory. He served as an experimental operator for about a year and a half, and then was promoted to chemical engineer in the same department. In 1937 he transferred to plant scale cracking research, doing work on thermal and catalytic cracking units. During the war McReynolds transferred again to the research department in catalytic cracking for work leading to the commercial application of the fluid cracking process. In recent years he has worked on thermal cracking of catalytic cycle gas oil.

The same year he joined The Texas Company, he married Miss Juanita Fields. Their two children are Marian, 8, and James Michael, 6. McReynolds golfs a little, fishes a little, and does a lot of hammering and banging and mowing and digging around the house, when the youngsters let him. He can be found at other times lending his tenor voice to the Texaco Male Chorus, a hobby he thoroughly enjoys. He is a member of ACS.

Diesel Fuel Problem Topic of SOD Trio

THE article entitled, "Wide-Cut Diesel Fuels," by Crampton, Hulse, and Rickles, of Standard Oil Development Company, which begins on page 139 of this issue is a technical report of importance to refining companies. Herein the authors discuss the use of a wide-cutting technique in preparation of diesel fuels for greater flexibility in the production of increased volumes of diesel fuels of unimpaired quality characteristics.

A. B. Crampton has been a member of the staff of Standard Oil Development Company since his graduation from Lafayette College in 1937, where he received a bachelor of science degree in chemical engineering. Presently, he is in charge of development and testing of aviation and diesel fuels for the Esso Laboratories, Research Division. Prior to and during the war he participated in the development of new processes for the manufacture of aviation gasoline and raw materials for synthetic rubber.

He is active in ASTM, Petroleum Section, D-2 Committee work, and is a member of several CRC committees. He is an "avid" golfer, but even so—two sons and a daughter have first call on his spare time.

S. H. Hulse points to the University of Michigan as his alma mater. He was graduated in 1925 as a mechanical engineer. A portion of his contribution as a member of this authors' trio is the wealth of experience in the world-wide fuel quality and manufacturing operations obtained from Standard Oil Company (New Jersey) which he joined after graduation. He is senior engineering associate in the Esso Laboratories, Process Division. As a member of the Navy Advisory Committee on Petroleum, and the ASTM Committee D-2, Technical Committee F, Hulse is in close contact with over-all technical and supply problems of diesel fuel. He participated in special weapons development as sponsored by the National De-

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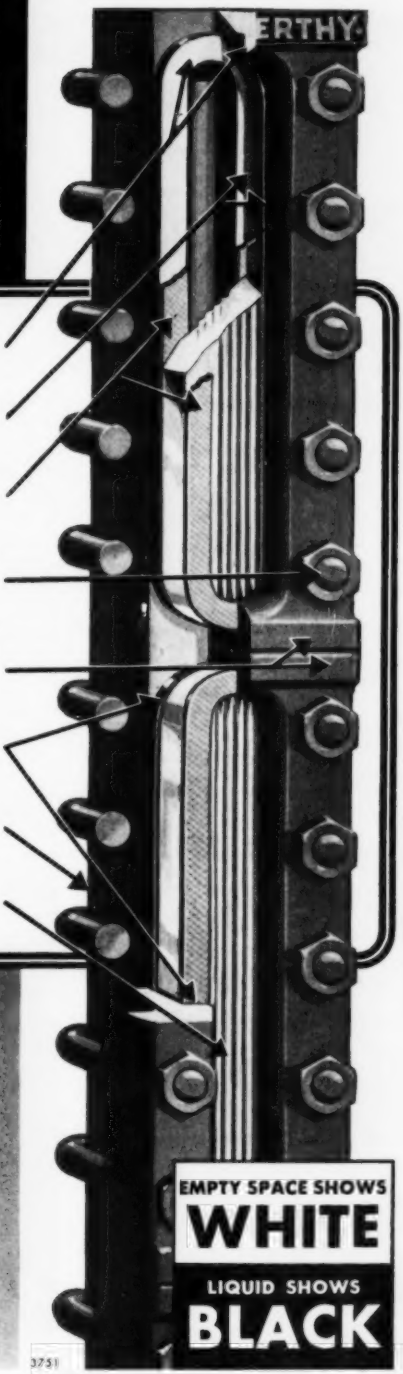

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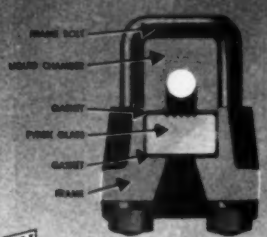

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fense Research Council during the war. Hulse attempts to devote his spare time to gardening, golf, and his children (two boys and one girl), with the result that he has little time for gardening and golfing.

N. H. Rickles joined the staff of SOD's Esso Laboratories research staff 21 years ago and has been actively connected with the development and application of fuels and lubricants during this period. Rickles was graduated from Yale's Sheffield Scientific School in 1923 as a mechanical engineer. For several years, he worked as assistant engineer of tests for the New Haven Railroad and test engineer for the International Motor Company (Mack Trucks). A well-known article written and published by Rickles in the SAE Journal of February, 1931, was titled "Cold Starting Characteristics of Automobiles." During the war Rickles participated in the CRC diesel fuel tests at the Ordnance Desert Proving Ground at Camp Seeley, the gasoline gum tests at Kelly Field, the program for the winterization of ordnance vehicles, an NDRC submarine project, and the development and testing of jet turbine fuels. He and Mrs. Rickles have one daughter.

Author Is Man of Great Versatility

DR. WALTER B. HOWARD has prepared the article "The Calculation of Rotameters," which begins on page 131 of this issue of PR. This article contains much of the information for which so many engineers engaged in design and operation of plants have needed many times. It is a "must" for studying and filing for future reference.

Dr. Howard has been associated with the Bureau of Industrial Chemistry at the University of Texas for the past ten years, where he has assisted on Dr. E. P. Schoch's electric discharge project used in the acetylene-from-gas process. His activities have consisted of work on research and pilot plant scales, on the basic electric discharge, on electric control circuits for the discharge, and on concentration of acetylene from gas mixtures.

Dr. Howard is an extremely versatile man. Included in his hobbies is music—he holds a life membership in the University Men's Glee Club and presently is interested in choir work. Another major interest, woodworking, especially period furniture and native South Texas woods. He puts his skill with tools to work occasionally on model boats. As the result of spending much of his boyhood on the coast near Corpus Christi, Texas, he naturally likes swimming and fishing in salt water. On the serious side, his hobby is the study of process control through instrumentation. He is active in Presbyterian church work.

During his graduate student years, Dr. Howard was awarded a University scholarship and a University fellowship. He has obtained all his degrees from the University of Texas — B.A., and B.S., M.S., and Ph.D. in chemical engineering. He is a member of Phi Beta Kappa, Phi Lambda Upsilon, Omega Chi Epsilon, and Sigma Xi (associate), American Chemical Society, American Institute of Chemical Engineers (junior) and the Austin Engineers and Associates Club (member of board of directors). He is a registered professional engineer in Texas.

Howard changed his name in 1942 to the "Howards," which goes double now with son Tom, going on 5½ and daughter Ann, four years Tom's junior.

WALTER B. HOWARD

Disposal Ideas Given

G. E. KING is author of the article, "Oil Separator for Refinery Waste-Water Disposal," which starts on page 117 of this issue of PETROLEUM REFINER. He presented the paper before the meeting early this month in Houston of the Refining Division of the American Petroleum Institute.

Graduating from the Indiana University in 1939 with a bachelor of science degree in chemistry, King joined the technical service division of The Standard Oil Company (Ohio). From 1942 to 1945 he was on a military leave of absence serving with the Army. Since his return he has been directing process development and control work on chemical refining, corrosion and waste disposal for Sohio.

How refineries of The Pure Oil Company and Sohio accomplished the disposal of their waste water and the recovery of oil lost to the refineries' sewers is told by King in his article. He presents a detailed description of the oil separator and the operating procedure developed during early operations, giving local factors that led to a modified design of the design recommended in the API publication, "Disposal of Refinery Wastes."

Napthas Discussed

CO-AUTHORS of the article, "Hydroforming and Thermal Reforming

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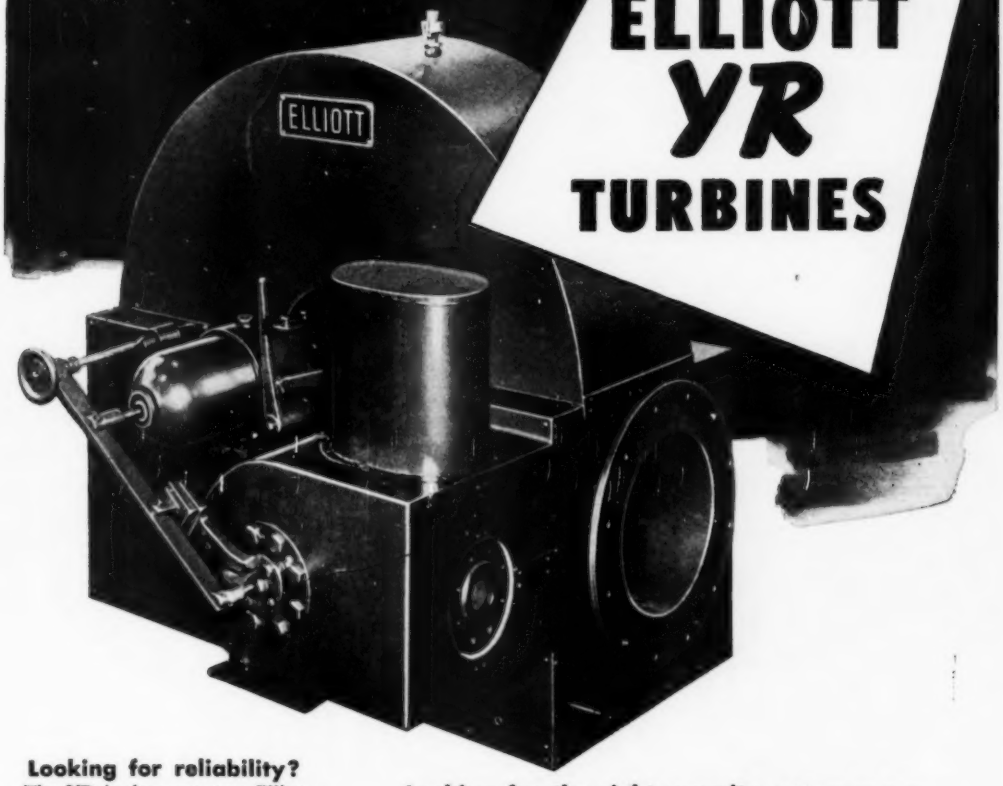

Looking for reliability?
The YR is the same type Elliott turbine that has made good for many years in every field, but now features standardized modifications which permit meeting special needs. It will fit in anywhere.

Looking for the right capacity without an oversize frame? These YR turbines offer *FIVE* frame sizes to cover a range to 2000 hp and speeds from 800 to 6000 rpm. Cast iron for low pressures, cast steel for high pressures and temperatures. The right size frame for your needs is certain to be among those five.

Looking for the right governor? Besides the standard independent emergency governor, you can have your selection of *SIX* governor types, giving you constant or variable speed, normal regulation, close regulation or any combination of these.

For full details and fully informative Bulletin RH-16 address STEAM TURBINE DEPARTMENT

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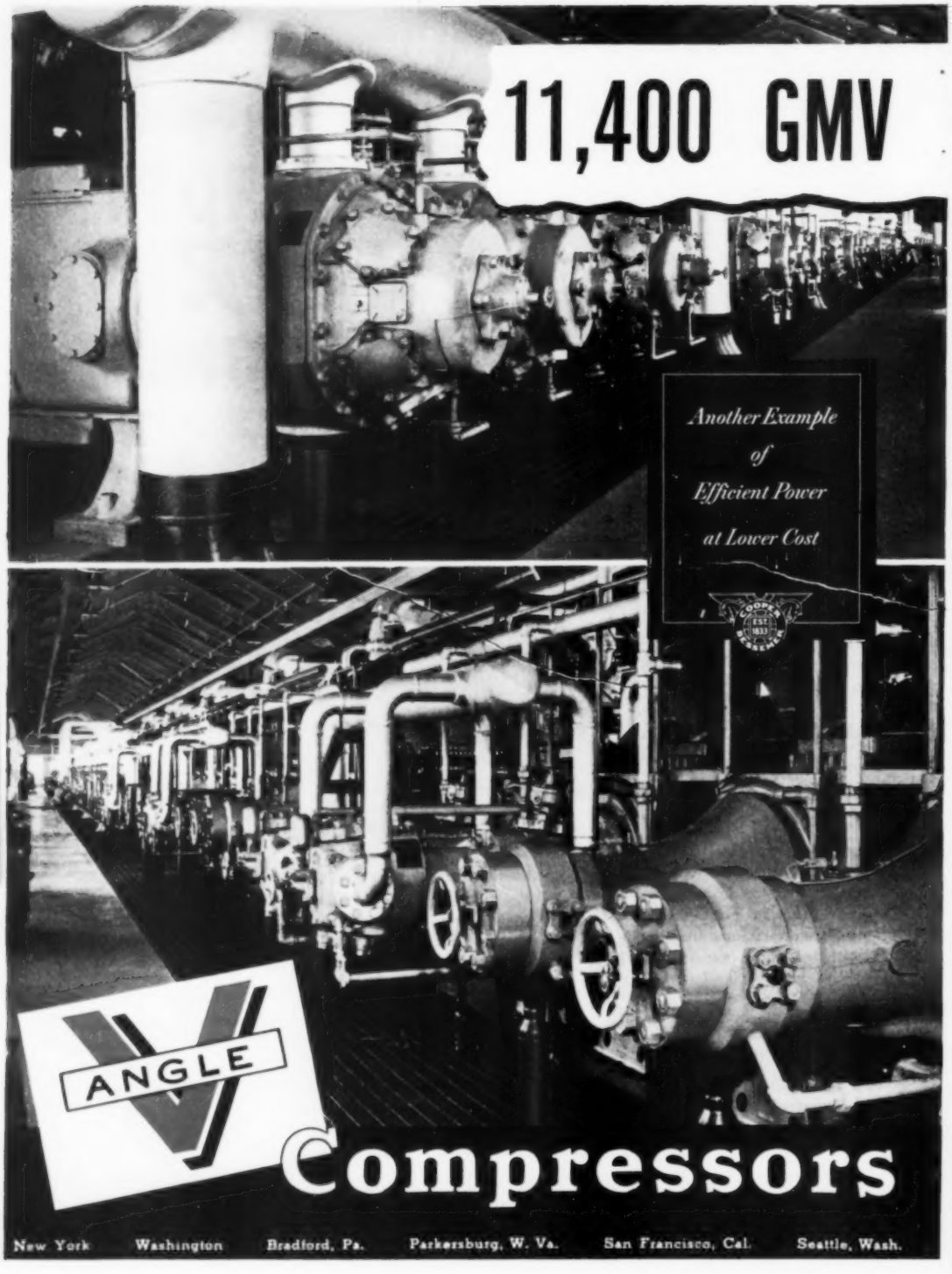
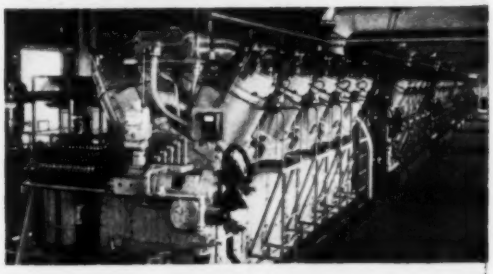

11,400 GMV
Another Example
of
Efficient Power
at Lower Cost
ANGLE
Compressors
New York
Washington
Bradford, Pa.
Parkersburg, W. Va.
San Francisco, Cal.
Seattle, Wash.

HORSEPOWER . . . hub of Stanolind's unique, multi-purpose operation in the Hastings field

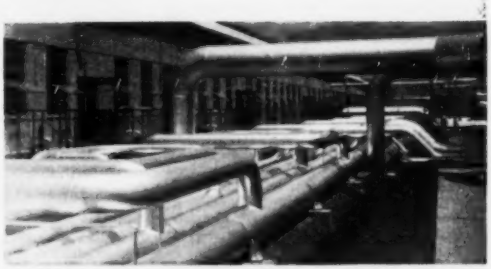
Twelve (12) modern Cooper-Bessemer GMV compressors shoulder an unusual multi-purpose job in Stanolind Oil and Gas Company's big, new, Hastings plant. This includes gas compression not only for natural gasoline processing, but for gas lift work in the field and underground storage as well.

All told, there are five stages of compression, from vacuum to a maximum of 5,000 psi — believed to be the widest compression range within the industry to date. Here also is the first application of underground residue gas storage in the Texas Gulf Coast area.

In this compressor installation, extreme flexibility is one of the prime essentials. The Cooper-Bessemer V-angles have a long and outstanding record of flexibility, adaptability to widely varying demand in pressure and flow. For that matter, you'll find these modern units to be outstanding in *many* ways . . . always adding up to efficient, dependable performance at low cost!



Engine view of 10 cylinder 1000 hp GMV compressor units from crank-door side showing V-type design, ignition and auxiliary lubrication equipment.

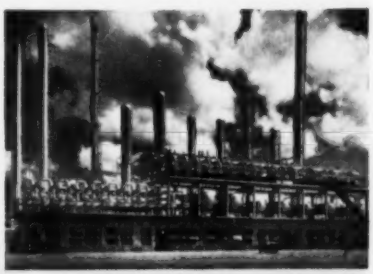


Low pressure manifolding for wet gas system. Block valves permit separation of system into two complete parts with separate inlet scrubbers, coolers and separators.

Six of nine 1000 hp GMV's handling wet gas into the Stanolind Oil & Gas Company's Hastings gasoline plant for processing. Each unit has 4 compressor cylinders for 3-stage compression from vacuum to 715 psia, handling 30 to 40 million cu. ft. per day. Units have semi-automatic, pneumatically operated unloading.

Foreground: Three 800 hp GMV's raise residue gas pressure through the first stage to 1570 psia or through the second stage to a discharge pressure of 3515 psia to 5000 psi maximum, with a capacity range up to 28½ million cu. ft. per day.

Three-story distillation structure shows coolers, main oil exchangers, accumulators, and enclosed pump room. The 10-cylinder GMV's deliver wet gas to absorbers at extreme left.



by **Cooper-Bessemer**

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N. H. McLAURIN, JR. C. H. McINTOSH DITMAS BROMLEY HENRY P. EVANS

Operations on Sweet and Sour Heavy Straight-Run Naphthas," starting on page 171 of this issue of PETROLEUM REFINER, are N. H. McLaurin, C. M. McIntosh and D. S. Kaufman. McLaurin read the paper before the 37th annual meeting of the Western Petroleum Refiners Association. He is a member of the Port Arthur, Texas refinery staff of The Texas Company, McIntosh is located in the New York offices and Kaufman, a former engineer for the company, now resides in Houston.

Neil Hugh McLaurin, Jr. was born on July 27, 1918, in Brookhaven, Miss., and following graduation from high school there in 1936 he entered Tulane University in New Orleans. He was graduated from Tulane in 1940 with the degree of bachelor of engineering in chemical engineering. He was a member of Tau Beta Pi, honorary engineering fraternity.

In June, 1940, he was employed by The Texas Company in their Port Arthur refinery and was assigned to the cracking research department of the research laboratory, in which department he has continued his services. Most of his work has been in laboratory research on pilot unit scale thermal and catalytic cracking operations. Additional work has been done on the correlation of fluid catalyst cracking data.

He was married in 1940 to Miss Katherine Buckley of Mendenhall, Miss., and they have one child, Neil Hugh, III. McLaurin is a deacon in the Baptist Church.

Claude Howard McIntosh was born on April 16, 1922 in Augusta, Ga. and after graduation from high school there in 1938 he attended the Junior College of Augusta for one year before enrolling in Georgia School of Technology in Atlanta. While there he was a member of Tau Beta Pi, Alpha Chi Sigma, and the Briaerean Society. His social fraternity was Lambda Chi Alpha. He was graduated from Georgia Tech in 1943 with a bachelor of science degree in chemical engineering, co-op plan.

In June, 1943, he also went to work for The Texas Company at their Port Arthur plant. Except for two years in the service, where he was an AETM 2/c with the Naval Air Transport Service, he has been assigned to the cracking research department of the research laboratory. Most of his work has been on pilot unit scale thermal and catalytic cracking and reforming operations.

He was married in 1944 to Miss Peggy Catanach of Port Arthur.

"Back to Nature" Sayeth This Author

TYLER G. HICKS is making his second appearance in the pages of PR with his article, "Refinery Steam Transmission Piping." See page 135. His first article was published in December, 1948, "Designing Efficent Gas Compressor Stations."

Before obtaining his degree in mechanical engineering from the Cooper Union School of Engineering in New York, where he was a member of Tau Beta Pi, engineering society, Hicks spent the early 30's sailing on tankers out of Gulf ports serving at every post from pumpman up, and got to see most of the big oil ports between the Gulf and the Far East.

JUNIOR AND TYLER HICKS

Since receiving his degree, he has worked in refineries on the Gulf Coast and has done design work on piping and refineries for a consulting engineer. Presently he is also trying small sub-contractors' design work.

Hicks has found that he likes to write articles for engineering magazines during his spare time. In addition he likes to read good fiction books and articles. When the time is available he likes billiards, golf, boating, and swimming. He reports that he thoroughly enjoys his young son, but thinks it would be nice if junior would concern himself with outdoor projects when it is time for the ol' man to do some work. Hicks says one of his current projects is a back-to-nature move which he hopes to make as soon as a small acreage can be found in the country.

Braun Authors Tell of Maintenance Musts

"MAINTENANCE Shops: The Layout and the Tooling," which starts on page 167 of this issue of PETROLEUM REFINER, is co-authored by Ditmas Bromley and Henry P. Evans. Both men have had wide experience with maintenance problems in their association with C. F. Braun and Company, Alhambra, Calif.

The authors point out that, in general, layout of maintenance facilities follows the pattern of poor tooling and disorder. A foundation of proper layout and proper tooling helps the maintenance department to become up-to-date and effective, a department that works fast and economically, keeps units on stream longer and shortens turnaround time to a minimum.

The article is illustrated with floor plans and sketches and should be a must for alert refinery management.

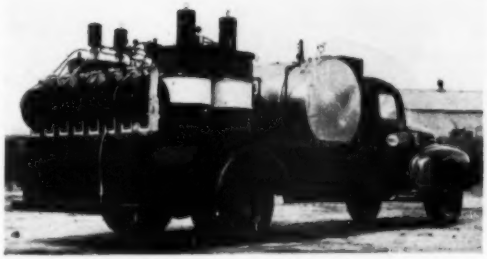
Maintenance and Operation—

HOW TO DO IT

HOW—

Service-Station-On-Wheels Serves Refinery Vehicles

ON-THE-SPOT-SERVICE is available to supply all vehicles with gasoline Diesel fuel, lube oil, water, and even air in the Baytown refinery of Humble Oil & Refining Company with the refueling truck shown in the accompanying photograph. Such machinery as draglines, tractors, hoist engines, portable generator sets and pumps, straddle-buggies, and similar equipment makes the refueling truck an extremely useful item, if not an economic necessity within a large refinery.



The service-station-on-wheels can be operated by one man with the simplified arrangement of drums, tanks, and hose reels. It eliminates the necessity of the numerous drums for storage of fuels at supply points throughout the plant where equipment as listed above is being used, and thus prevents waste of fuel and oil. Time savings are realized by the operators since their equipment can be refueled quickly by the truck.

HOW—

Hydraulic Lift Increases Safety

The photograph shows operator at control lever of hydraulic lift on a truck for loading and unloading petroleum products in barrels from the ground level. The lift, a commercial product, was installed by a major oil company on the West Coast to make the operation a safer and quicker one for employes. The hydraulic lift eliminates the accident hazard prevalent in manual handling of the drums. In addition, damage to the drums is eliminated, loading and unloading is simplified and speeded, and the work can be performed by one operator.

HOW—

Shield Protects Fire Fighters

THE metal shield, fastened to the nozzle mounting of the turret-type deluge nozzle in the photograph, protects the operator from the heat during a fire. This installation in the Heath refinery of The Pure Oil Company. Of lightweight sheet iron, the shield is fastened to the nozzle mounting with strap iron brackets and bolts.

In fighting a fire, flooding the exposed adjacent equipment—vessels, piping, and heat exchangers—with a stream of water, protects it from radiant heat, aiding greatly in preventing the fire from spreading.

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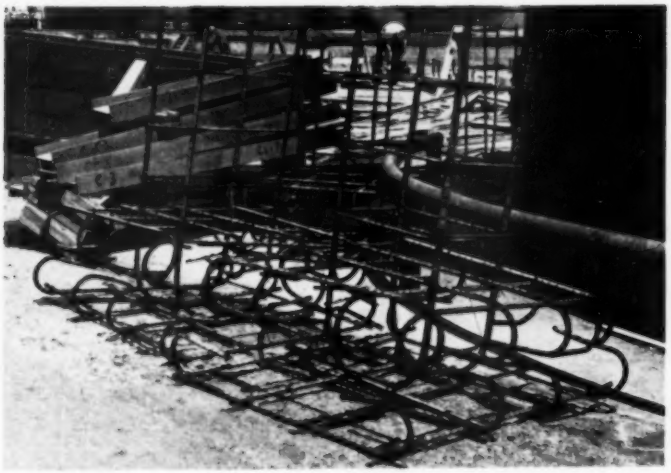

Figure 1. Prefabricated reinforcing steel assemblies ready for inserting into plywood forms for pouring concrete piers in construction of refinery equipment foundations.

HOW

Prefabricated Forms Help Speed Plant Construction

CONSTRUCTION of new additions to existing refinery equipment involving concrete foundations can be accomplished with less delay and waiting time when the forms and reinforcing steel assemblies for the concrete piers are prefabricated in the plant's carpenter, machine, and welding shops.

Reinforcing bars, for example, are shaped, tied, and tack-welded in the shop, then hauled to the location for inserting into the wooden forms where concrete is poured for the supporting piers as shown in Figure 1.

In one specific case involving delayed coking vessels, the piers required for the base were all alike, including the reinforcing steel and its arrangement. The forms for these piers were made in the carpenter shop of plywood sections. Since only two different sizes of sections were needed for the sides and ends of each pier, they were cut from plywood and stacked for the assembly carpenter. Then each section of plywood was reinforced horizontally with 2x2 wooden beams spaced at equal intervals as shown in Figure 2. The beams were extended beyond the sides of the sections and used in fastening the form together during erection.

Figure 2 also shows the location of holes for tie wires drilled in the sections for tying the sides to prevent them from bulging due to the weight of the concrete. The vertical members used as tie-bar anchors for the 2x2 braces were 1x2 wooden strips nailed in place.

The plywood forms rested on the main concrete pad in the bottom of the excavation, so that cross ties or rests to support the foundation bolts were positioned easily. The foundation bolts, shown in Figure 3, were made in the plant shop. In the design used, both ends of the bolts are threaded and the nut on the lower end is welded in place. A flat square steel anchor plate is added and then the stovepiping, which is lightweight pipe, is attached to the bolt at one point by pieces of reinforcing steel tack welded to both the stove piping and the bolt. This method places the top of each tube the same distance from the anchor plate on each bolt.

During pouring of the concrete, a piece of 1x4 board with holes drilled for the anchor bolts is placed across the form to prevent concrete entering the stovepipe.

Removal of the forms when the piers are completed is a simple job. All that is required is for the carpenter to pull a few nails and clip the ends of the snugging wires and the plywood sections are removed for use on other piers.

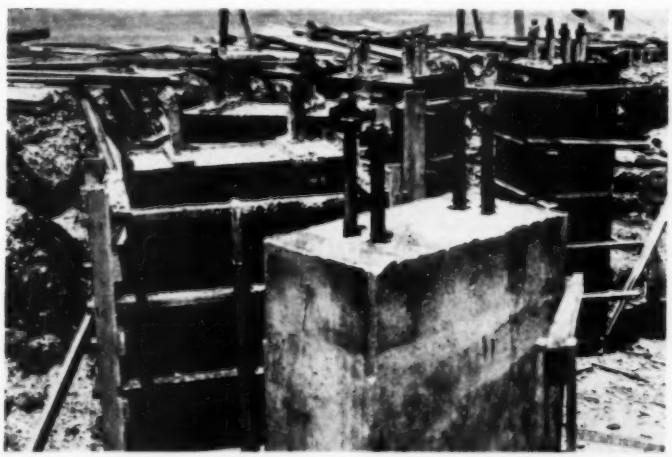

Figure 2. The plywood form was removed quickly and easily from the concrete pier in the foreground. The method of erecting the forms for the piers and fastening the sections together is shown on the next pier. Note the snubbing wires tied to the vertical wooden beam in the center of the side to keep the form from bulging, and the 1 x 4 strips of wood placed across the anchor bolts to prevent concrete entering the stove-pipe during pouring of the form.

Figure 3. Pier foundation anchor bolt made in the refinery's machine shop with anchor plates, stovepiping, and nuts ready for installation in the reinforcing cage. Stovepipe sleeves are connected to the anchor bolts at the base of the sleeves by short bars tack-welded to the anchor bolt.

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THE MONTH in the INDUSTRY

* * *

Kuhn Points to Progress Being Made by Technology

The oil industry is currently spending more than $125 million for equipment to remove corrosive sulfur compounds from the products of foreign and domestic sour crudes, according to Dr. Wayne E. Kuhn, The Texas Company and chairman of the ACS Petroleum Division. This may involve "an expenditure of more than $7 million for an average-sized refinery (50,000 barrels daily) but the increase in refining costs has been absorbed by the manufacturer and has not increased prices."

Dr. Kuhn said this accomplishment is a tribute to the industry's technologists, pointing out that in recent years new processes have been developed that will produce "better motor fuels from almost any grade of crude than was formerly possible from the best."

The industry is making progress in the development of processes for the recovery and purification of the important chemical by-products of the synthesis operation, Dr. Kuhn declared, and "the industry expects that the processes for chemical recovery will add to the attractiveness of the synthesis operation from an economic standpoint. Synthetic fuel manufacture has been developed to such an extent that some synthetic fuels may be a component part of the high-octane gasolines to be marketed during the current year."

Any government effort or activity should be applied constructively and be so directed as to further stimulate private investigations and private production of synthetic fuels, Dr. Kuhn urged. A healthy synthetic fuel industry can best be established by retaining the element of technological competition.

The chairman of the two day symposium on sulfur is Dr. A. A. O'Kelly, of Socony-Vacuum. Papers are to be presented on new techniques for removing sulfur from crude stocks, the production of sulfur compounds as chemical by-products, and the corrosive effects of sulfur on refinery metals.

A second symposium on Micro-Chemistry is to be held under the chairmanship of Harry Levin of The Texas Company. Papers will be given on the training of micro-chemists for the oil industry and the application of microchemical technques to industrial pollution problems.

A. L. Lyman, vice-president of the California Research Corporation is local chairman of arrangements.

Calendar of Meetings

APRIL	
11-12	American Institute of Electrical Engineers, New York, Statler Hotel.
11-12	American Society of Lubrication Engineers, Annual Meeting, New York, Hotel Statler.
11-13	Midwest Gas Association, Annual Convention, Des Moines, Hotel Ford Des Moines.
11-13	National Association of Corrosion Engineers, Cincinnati, Netherlands-Plaza Hotel.
11-15	Western Metal Congress and Exposition, Los Angeles, Shrine Civic Auditorium.
12-14	Southwestern Gas Measurement Short Course, Norman, University of Oklahoma.
13-15	National Petroleum Association, Cleveland, Hotel Cleveland.
18-20	Midwest Power Conference, Annual Meeting, Chicago, Hotel Sherman.
20-22	Southern Gas Association, Annual Convention, Biloxi, Buena Vista Hotel.
20-22	Natural Gasoline Association of America, Fort Worth, Texas Hotel.
25-29	The American Society of Mechanical Engineers, Oil and Gas Power Division, Chicago, Hotel Sherman.
28	Society of Automotive Engineers, New York, Engineering Societies Building.
MAY	
2- 4	Independent Petroleum Association of America, Mid-Year Directors Meeting, New Orleans.
2- 4	The American Society of Mechanical Engineers, Spring Meeting, New London.
8-12	American Institute of Chemical Engineers, Regional Meeting, Tulsa.
9-10	American Petroleum Institute, Division of Marketing, St. Louis, Jefferson Hotel.
9-10	American Gas Association, Natural Gas Department, Spring Meeting, French Lick, French Lick Springs Hotel.
9-11	Liquefied Petroleum Gas Association, Annual Convention and Trade Show, Chicago, Palmer House.
10-12	Interstate Oil Compact Commission, Jacksonville, Roosevelt Hotel.
12-13	Instrument Society of America, Annual Spring Meeting, Toronto, Canada, Royal York Hotel.
MAY	
12-13	American Gas Association, Executive Conference, San Francisco, Fairmount Hotel.
16-19	National Fire Protection Association, San Francisco, Fairmont Hotel.
16-20	Oil Heat Institute of America, Annual Meeting, Boston, Statler Hotel.
17-19	Pennsylvania Gas Association, Annual Convention, Wernersville, Galen Hall.
23-25	American Gas Association Production and Chemical Conference, New York, Hotel New Yorker.
26	Society of Automotive Engineers, Diesel Engine, New York, Engineering Societies Building.
26-27	The Natural Gas and Petroleum Association of Canada, Annual Meeting, London, Ontario, Hotel London.
30 to June 1	Fourth Annual Short Course in Gas Technology, Kingsville, Texas, A & I College.
JUNE	
5-10	Society of Automotive Engineers, Summer Meeting.
12-16	Instrument Society of America, Annual Convention, St. Louis, Municipal Auditorium.
16-20	Canadian Gas Association, Annual Convention, Lake of Bays, Ontario, Canada, Bigwin Inn.
17-20	American Gas Association, Annual Convention, Chicago.
24-25	Michigan Gas Association, Annual Convention, Mackinac Island, Grand Hotel.
24-28	National Safety Council, Chicago, Morrison Hotel.
27-30	The American Society of Mechanical Engineers, Semi-Annual Meeting, San Francisco.
27 to July 1	American Society for Testing Materials, Annual Meeting, Atlantic City, Haddon Hall, Hotel Chalfont.
SEPT.	
14-16	National Petroleum Association, Atlantic City, Hotel Traymore.
18-20	American Institute of Chemical Engineers, Montreal, Canada, Mt. Royal Hotel.
19-21	National Butane-Propane Association, St. Louis.
28-30	The American Society of Mechanical Engineers, Fall Meeting, Erie.

API President Announces Six 1949 Committee Groups

William F. Boyd, Jr., president of the American Petroleum Institute, has announced members of six committees, as follows:

Research Committee, Robert E. Wilson, Standard Oil Company (Indiana), Chicago, chairman.

Safety Committee, John R. Suman, Standard Oil Company (New Jersey), New York, chairman.

National Oil Policy Committee, A. Jacobsen, Armerada Petroleum Corporation, New York, chairman.

Committee on Nominations, George A. Hill, Jr., Houston Oil Company of Texas, Houston, chairman; Hines Baker, Humble Oil & Refining Company; H. S. M. Burns, Shell Oil Company, Inc.; Robert H. Colley, The Atlantic Refining Company; H. D. Collier, Standard Oil Company of California; Jake L. Hamon, Cox & Hamon; W. Alton Jones, Cities Service Company; L. F. McCollum, Continental Oil Company; N. C. McGowen, United Gas Pipe Line Company; Frank M. Porter, Eain-Porter Drilling Company, and A. Jacobsen, Amerada.

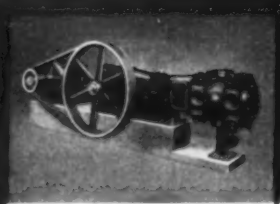
Harry T. Klein, The Texas Company; A. C. Mattei, Honolulu Oil Corporation, Ltd., and Robert H. Colley, The Atlantic Refining Company, will serve three-year terms on the committee for awards.

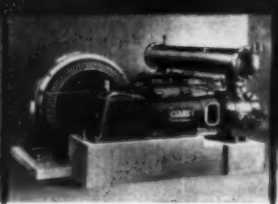
Frank Phillips Resigns As Chairman of Company

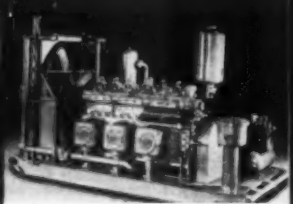
Frank Phillips, chairman of Phillips Petroleum Company, last month announced his wish to be relieved of active management responsibilities in the company which bears his name and which he founded in 1917. In a letter addressed

The Right Compressor

TYPE OF COMPRESSOR	STRAIGHT LINE HORIZONTAL COMPRESSORS	MOTOR-DRIVEN HORIZONTAL COMPRESSORS	MIDGET ANGLE COMPRESSORS
RANGE OF HP			
			75 to 600 BHP
		75 to 1,000 BHP	
	5 to 125 BHP		







CHOICE OF DRIVE			
Electric	5 to 125 BHP	Duplex 75 to 300 BHP	Gas Engine 75 to 330 BHP
Gas Engine	5 to 125 BHP	Balanced Opposed 150 to 1,000 BHP	Diesel 100 to 400 BHP
Steam	5 to 125 BHP		Electric 150 to 600 BHP
Gasoline	5 to 125 BHP		
Diesel	5 to 125 BHP		
Turbine	5 to 125 BHP		

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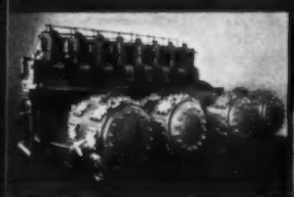
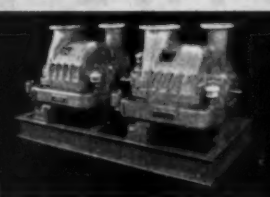
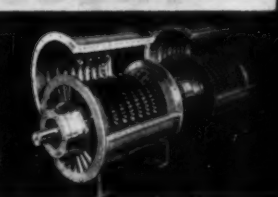
			To 30,000 BHP
		300 to 22,000 BHP	
	1,000 to 5,000 BHP		
200 to 4,000 BHP			

With the addition of the new Clark Axial Flow Compressor to the line, Clark now offers the most complete selection for any specific compressor application. Whatever your requirement may be—in capacity or type of service—we can furnish the right compressor, one that represents sound engineering and the finest precision manufacturing.

This chart indicates the over-all range of the Clark line of compressors. Space does not permit illustrating all types of drives, but you are invited to write for booklets containing detailed information. We have greatly expanded our manufacturing facilities in order to meet the increased demand for these products that are "setting the pace in compressor progress".







Gas Engine 200 to 880 BHP Diesel 200 to 800 BHP Steam 450 to 4,000 BHP Electric 400 to 2,000 BHP	Gas Engine 1,000 to 2,200 BHP Diesel 1,000 to 2,000 BHP Electric 1,500 to 5,000 BHP	Steam Turbine Electric Gas Turbine 1,500 BHP & UP	Steam Turbine Electric Gas Turbine 1,500 BHP & UP

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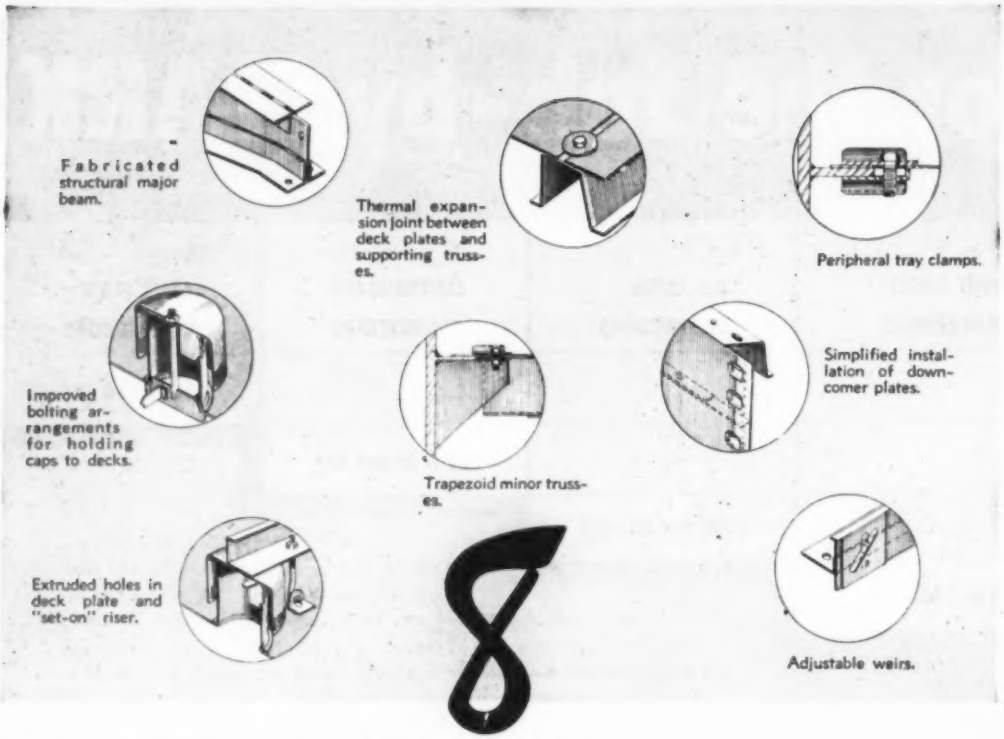
Fabricated structural major beam.
Thermal expansion joint between deck plates and supporting trusses.
Peripheral tray clamps.
Improved bolting arrangements for holding caps to decks.
Simplified installation of downcomer plates.
Trapezoid minor trusses.
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"TRUSS-TYPE" BUBBLE TRAYS ● BUBBLE CAPS ● TOWER INTERNALS

THE MONTH...

to K. S. Adams, president, Phillips congratulated the management and the employe organization in "the promising future of the company." He insisted, however, that his name not be included on the list of nominees for directors to be submitted at the forthcoming annual meeting of stockholders in Bartlesville, Okla., on April 26.

Members of the board expressed their intention to discontinue the office of chairman of the board and to create for Phillips the new title of honorary director and honorary chairman, without voting or management responsibilities.

Drucker Appointed

Joseph J. Drucker has been named manager of the estimating and cost control department of Catalytic Construction Company, Philadelphia.

Drucker

Previously he was employed by Foster-Wheeler Corporation for 20 years. During the past four years, Drucker has been chief estimator of the oil division of Arthur G. McKee and Company.

He is a graduate of Cooper Union Institute of Technology with a degree in mechanical engineering.

McDowell Succeeds Ashton as Head of Western Petroleum Refiners Association

C. C. PRYOR, Associate Editor

R. W. McDowell, executive vice president of Mid-Continent Petroleum Corporation, Tulsa, was elected president of the Western Petroleum Refiners Association at the 37th annual convention held in San Antonio, Texas, March 28-30. He succeeds H. T. Ashton, midwest sales director of Socony-Vacuum Oil Company, St. Louis.

Vice presidents elected for the coming year are F. L. Martin, Sunray Oil Corporation, Tulsa; R. L. Tollett, Cosden Petroleum Corporation, Big Spring, Texas; H. E. Zoller, Derby Oil Company, Wichita, Kansas, and Roland V. Rodman, Anderson-Pritchard Oil Corporation, Oklahoma City.

New directors of the association are W. J. Carthaus, Deep Rock Oil Corporation, Tulsa; Harry J. Kennedy, Continental Oil Company, Ponca City; Brown Meece, Globe Oil & Refining Company, Chicago, and M. H. Robineaux, Frontier Refining Company, Cheyenne, Wyo.

Speakers at the convention presented discussions on subjects ranging from economics of refining techniques, new processes and applications, jet engine fuel and lubricant specifications to federal action toward divorcement of large oil companies and their subsidiaries.

Gordon C. Locke, general counsel and executive director of the newly formed committee for pipe line companies, told the convention that divorcement bills had been proposed 13 or 14 times during the past few years, but that Congress had not reported favorably on any of them. He pointed out that continued introduction of such bills would eventually lead to their passage. The association adopted a resolution opposing the Gillette oil divorcement bills.

President Ashton, commenting on the divorcement bill in his address said that the oil industry by it would be handicapped in meeting its vital obligation to the nation. Any plan to destroy the internal relationships would completely disintegrate the entire industry, he said.

"Hydroforming and Thermal Reforming Operations on Sweet and Sour Heavy Straight-Run Naphthas" was presented by N. H. McLaurin, C. H. McIntosh, The Texas Company and D. S. Kaufman. (See page 171.)

The change from a sellers to a buyers market probably will result in an octane race with catalytic cracking a necessity for virtually all refiners, according to Dr. C. C. Peavy and Messrs Weinrich, Hornaday, and Noll of Houdry Process Corporation, Philadelphia. Noll's presentation, "Various Refinery Applications of Houdriflow Catalytic Cracking" was a discussion of the results of the over-all refining economics for various methods of feed stock preparation for Houdriflow catalytic cracking while minimizing residual fuel oil. The speaker discussed the improved Houdriflow process.

New liberalized specifications for jet engine fuels will enable refiners to make as much as 50 percent of a barrel of crude oil into jet fuel, compared with about 5 percent under present specifications, according to C. R. Hudson of the Air Materiel Command at Dayton, Ohio. Hudson listed the new specifications for jet fuel in his presentation, "Fuels and Lubricants for Turbo-Jet Engines" as: freezing point, not higher than —60° C. (—78° F.); non-corrosive; aromatics, not to exceed 25 percent by volume; sulfur, not to exceed 0.5 percent by weight; gravity, 45 to 63° API; vapor pressure, at least 5 psi. (Reid), but not higher than 7 psi.; gum, not to exceed 20 milligrams per 100 milliliters of fuel; distillation, temperature at the 90 percent evaporated point shall not be less than 204.4° C. (400° F.) and the endpoint shall not exceed 315.5° C. (600° F.). Residue shall not exceed 1.5 percent. Distillation loss shall not exceed 1.5 percent. Bromine number shall not exceed 1.5 percent, and the heat of combustion shall not be less than 18,400 Btu. per pound.

Suitable lubricants that must be found and developed for future aircraft and missiles, and improvement of existing products are formidable problems that the Air Force and Aeronautical Services, even with outside contracts for research and development, cannot solve without the aid of the petroleum industry, Lt. Colonel H. A. Messman, USAF, engineering division, Air Materiel Command, Dayton, Ohio, told the refiners. In his discussion of "The Research and Development of Specialty Petroleum Products for Jet Aircraft," Messman said that in addition to the requirements of the armed services, commercial aviation is an even larger outlet for lubrication products.

Announcement of a new catalytic reforming process using platinum catalyst for the quality improvement of straight run or natural gasoline was announced by Edwin F. Nelson, Universal Oil Products Company, Chicago, in "Trends in Petroleum Refining."

The new process, "platforming," according to Nelson, combines many of the best features of both hydroforming and thermal reforming. The process operates continuously and is non-regenerative. It converts naphthenes to aromatics, high boiling paraffins to lower boiling paraffins, and isomerizes the low boiling paraffins. Equipment for the plant involves preheating and reactor vessels, recycle gas compressor, and conventional fractionation for feed preparation and product recovery.

Installation cost for a 5000-barrel per day unit, Nelson said, is about $1.7 million, which approximates the cost of a thermal reforming unit plus a polymerizing unit. Operating cost is slightly higher than a thermal reformer and polymerization unit for the same octane level. The process is now available to refiners, Nelson said.

Results of a laboratory study of the storage stability of distillate fuel oils, particularly those from cracking processes, were presented by E. L. Korb, H. J. Scheule, and R. O. Bender, petroleum laboratory, E. I. du Pont de Nemours & Company, Wilmington, Del., in "Investigation of Distillate Fuel Oil Stability." The laboratory work has been directed to correlation of data obtained from the accelerated bomb test method and other methods with drum storage and to development of the basic factors involved in fuel oil deterioration. According to the authors, the study has revealed that the rate of deterioration is only one factor, though perhaps the most important one, in the chain of events leading to customer dissatisfaction with an unstable fuel oil.

The Texas Company Plans El Campo Compressor Plant

The Texas Company plans an addition to the Magnet-Withers Field compressor plant, near El Campo, Texas, for compressing low pressure gas from several operators in the field and making it available for gas lift purposes or for sale.

Three 600-horsepower compressors will be installed to increase the capacity of the plant by 9 million cubic feet per day.

The contract to install the compressors has been let to Tellepsen Construction Company, Houston.

Danciger Refinery to Be Dismantled, Sent to Italy

The 7500-barrel per day refinery near Longview, Texas, formerly owned by Danciger Oil & Refining Company has been purchased by the Italian firm of Raffinerie Siciliane Olii Minerali, S. A. (RASIOM), of Milan, Italy.

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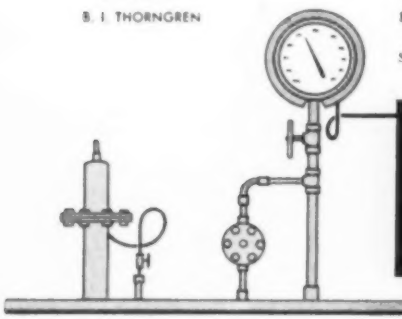

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THE MONTH . . .

Longview is being done by Delta Engineering Corporation of Houston. Mechanical design and detailed equipment specifications and complete drawings for re-erection at Augusta, Sicily, is under preparation by Delta, as well as modification of some of the equipment for use in processing sour crude oil. Dismantling is expected to be completed by June 15.

The cracking unit is being redesigned by Universal Oil Products Company (process licensor) to increase the capacity to 10,000 barrels per day of tanker-transported Arabian (Abqaiq) sour crude oil. A propane recovery unit, designed by Delta, will be added to the plant in Augusta. The construction of liquefied petroleum gas cylinder filling facilities and lube oil manufacturing facilities also is contemplated by RASIOM.

Supervising the dismantling of the plant is S.T.I.I., an Italian construction firm represented by Dr. P. C. Bazzocchi and Carlo Galetti. S.T.I.I. will re-erect the plant at Augusta.

Pan American Stops Project

"Due to a decline in oil product prices and the uncertain outlook for the oil industry for the future," Pan American Refining Corporation has stopped construction on its main office building and an addition to its research laboratory at Texas City, Texas. The $1 million building program does not involve any refining or production facilities. The program will be resumed in a few months if circumstances are more favorable in coming months, the company said.

Canadian Shell to Build

Shell Oil Company of Canada, Ltd., has awarded contract for a new oil refinery near Montreal, Canada. The project will double crude throughput to about 27,000 barrels daily. Extension and additions to the gas polymerization plant and gas recovery and treating facilities are planned also. Arthur G. McKee and Company has the contract for a catalytic cracking unit and vacuum flashing unit. Fluor Corporation of Canada, Ltd., also has been awarded a contract.

Syrian Refinery Planned

Syrian-American Oil and Gas Company has been formed by James W. Menhall, Illinois independent producer, with $100 million authorized capital, to finance a 12,000-barrel daily refinery to be built at the Mediterranean coast town of Lattaquie, Syria. Menhall has not yet determined whether a new plant will be built on the site or an unused plant of that size will be purchased in the United States, dismantled and shipped to Syria.

Skelly to Modernize

Skelly Oil Company is planning to enlarge and modernize its refinery at El Dorado, Kans. The cost is estimated at $8 to $10 million. Capacity of the plant will be increased to 35,000 barrels daily.

A catalytic cracking unit under construction is expected to be completed this year and a new crude unit will be started later in the year.

Foster Wheeler Promotes Two Executive Officers

Vice Admiral Earle W. Mills, USN (Ret.), has been elected executive vice president and a director of Foster Wheeler Corporation, and David McCulloch, formerly executive vice president, has been named vice chairman of the board.

Mills

Wartime deputy chief of the bureau of ships, Navy Department, and chief of that bureau since 1946, Admiral Mills recently retired from the Navy.

He was graduated from the U. S. Naval Academy in 1917 and received his degree as master of science in naval engineering from Columbia University in 1924. He was awarded the honorary degree of doctor of engineering by the University of Louisville in 1944.

McCulloch joined Power Specialty Company, later to become part of Foster Wheeler Corporation, in 1906. He has served as executive vice president since 1935.

Socony-Vacuum Announces $60 Million Expenditures

Capital expenditures of $60 million for major replacement and expansion projects in six of its refineries have been announced by Socony-Vacuum Oil Company, Inc. The projects, most of which were started in 1948, are expected to be completed this year at refineries in Brooklyn, N. Y.; Paulsboro, N. J.; Beaumont, Texas; Torrance, Calif.; Casper, Wyo.; and East St. Louis, Ill.

Domestic refineries of Socony-Vacuum set a record in 1948 when they processed a daily average of 472,000 barrels of crude oil. This is 12,000 barrels a day more than in 1947 and 60,000 more than in 1946.

Refineries in Frontignan and Gravenchon, France, and in Naples, Italy, processed an average of 19,000 barrels of crude a day, an increase of 8000 barrels daily over 1947. Major progress was made during the year in reconstructing these war-damaged refinery facilities.

Monsanto Dedicates Rebuilt Texas City Styrene Plant

The newly reconstructed Monsanto Chemical Company plant at Texas City, Texas was dedicated April 8, nearly two years from the day the styrene plant was destroyed by the explosion of the nitrate-laden SS Grandcamp. Highlight of the dedication was the unveiling of a memorial to the 145 Monsanto employes who lost their lives in the disaster. H. K. Eckert, plant manager, gave an address.

In the afternoon a symposium, dedicated to the new plant and the conservation of the petroleum and chemical resources of Texas, was held in Houston. Speakers included Paul Weaver, past president of the American Association of Petroleum Geophysicists; W. J. Murray, Jr., chairman of the Texas Railroad Commission; and Dr. Richard Gonzalez, economist for Humble Oil & Refining Company. Dr. William V. Houston, president of Rice Institute, presided as moderator.

Speaker of the evening was Dr. Karl T. Compton, director of the research and development board, U. S. Department of Defense and chairman of the board of Massachusetts Institute of Technology, who discussed "Men and Ideas: The Objective and Resource of Our Scientific Educational Institutions." William M. Rand, president of Monsanto, also spoke.

Mathieson to Purchase Standard Wholesale Works

Mathieson Chemical Corporation has contracted to purchase the assets and business of Standard Wholesale Phosphate & Acid Works, Inc., Baltimore, Md. Principally engaged in the production and sale of sulfuric acid, superphosphates and mixed fertilizers, Standard's largest plant is located at Baltimore.

Mathieson recently acquired Southern Acid & Sulphur Company, Inc. also. The company feels that by purchasing these two companies it will diversify its production and enlarge its sales territory for its products as well as obtaining productive and shipping facilities.

Magnolia Establishes New Fellowship in Chemistry

Magnolia Petroleum Company has established a fellowship in the department of chemistry at the University of Texas. Socony-Vacuum Oil Company and its affiliated companies contemplate the placement of approximately 20 fellowships and to date 15 have been established. Among these are fellowships at the University of Oklahoma in chemical engineering and at Rice Institute in physics.

Fellowships are awarded annually and carry a stipend of $2000 each.

In addition, an educational grant is made annually to an outstanding technical employee selected from some one of the Company's laboratories.

Micro-Chemical Fellowship

The Texas Company has established a graduate fellowship in micro-chemical analysis at New York University, believed to be the only fellowship of its kind in existence. Its purpose is the comparative study of methods for determining the presence of sulphur in organic materials by micro-chemical techniques.

Work will be directed by Dr. John E. Vance, head of the Department of Chemistry.

Sinclair Lets Contract

Sinclair Oil and Refining Company has started construction on a refinery at Puerto la Cruz, Venezuela. Engineering and construction on the 35,000-barrel project will be under the direction of Frederick Snare Corporation.

Named by Armour Foundation

Walter J. Armstrong, associated since 1945 with the Foundations program in Mexico, has been named manager of Mexican operations for the International Division of Armour Research Foundation of Illinois Institute of Technology.

One of the co-discoverers of a proc-

THE MONTH...

ess for obtaining henequen wax, Armstrong since 1947 has been in charge of the chemical engineering phases of the work in Mexico City assisting in the design of the Foundation's new laboratory there.

Magnolia Names Hanley

R. D. Hanley has been elected a vice president of Magnolia Petroleum Company.

Hanley started with Magnolia Gas Company in June, 1925 after graduating from Texas A. & M. College. Five years later he transferred to Magnolia Petroleum as chief chemist of the natural gas department. In 1938 he was made general superintendent of that department and in April, 1942 was advanced to manager. On January 1, 1948 Hanley was elected to the board of directors of the company.

Du Pont Promotes Three

Joseph J. Mikita has been promoted to director of the petroleum laboratory of E. I. Du Pont de Nemours and Company, Inc. The laboratory conducts research on the performance of fuels and oils in automotive engines.

Appointment of the heads of three laboratory divisions also has been made. They are Richard O. Bender, chemical; Milton H. Campbell, engineering; and Robert H. Hobart, service.

Shell's Western Budget

Shell Oil Company, Inc., has approved a $33 million budget for its Western operations during the coming year. This is the largest Western budget in the history of the company. Improvement of refining and marketing plant facilities are included as are enlarged transportation terminals, and expanded research facilities.

Commercial Synthetic Fuel Industry Is Recommended

Although natural petroleum supplies have improved, Undersecretary of the Interior Chapman, before the American Society of Civil Engineers in Washington last month, recommended that a program be started soon to build a commercial synthetic liquid fuels industry with a capacity of two million barrels daily.

Need for "commercial-size plants with a substantial daily production of synthetic petroleum to keep our industrial machine working at full capacity and to provide for oil in the event of war," was stressed by Chapman.

With half of the energy consumed in the United States supplied by exhaustible resources of oil and gas and use of coal and water power declining, "the country is faced with the task of meeting a 50 percent increase in total energy consumption and yet decreasing the pressure on exhaustible energy resources," he added. "Needed is a domestic oil industry capable of supplying our essential needs," Chapman explained. "This means we must explore and develop to the fullest the making of petroleum from other resources that are plentiful."

Edwin F. Nelson Honored

Edwin F. Nelson, vice president of Universal Oil Products Company, was presented a citation award from the University of Wisconsin, College of Engineering, for distinguished contributions to chemical engineering in the petroleum industry in connection with the activities of Universal.

The award was presented March 15 by E. B. Fred, president of the university, and M. O. Withey, dean of the College of Engineering.

ASTM Committees Meet

New specifications and tests for materials, revisions and new research work was discussed during the Committee Week, held the week of February 28, of the American Society for Testing Materials. Final consideration of the issues will be taken at the annual meeting of the society in Atlantic City during the week of June 27. Among the committees meeting was D-2 on Petroleum Products and Lubricants.

R. E. Borden Appointed LPGA Publicity Director

Robert E. Borden has been appointed director of publicity and advertising for the Liquefied Petroleum Gas Association.

For many years publicity director of Commonwealth Edison Company, he also served in various advertising and editorial capacities with the Chicago utility. He recently has been identified with the National Patent Council, American Fair Trade Council and Anderson Company as director of publicity and publications.

Borden was president of the Publicity Club of Chicago in 1945-46 and president of the Industrial Editors Association of Chicago in 1934.

Krug and Boyd Point to Importance of Synthetics

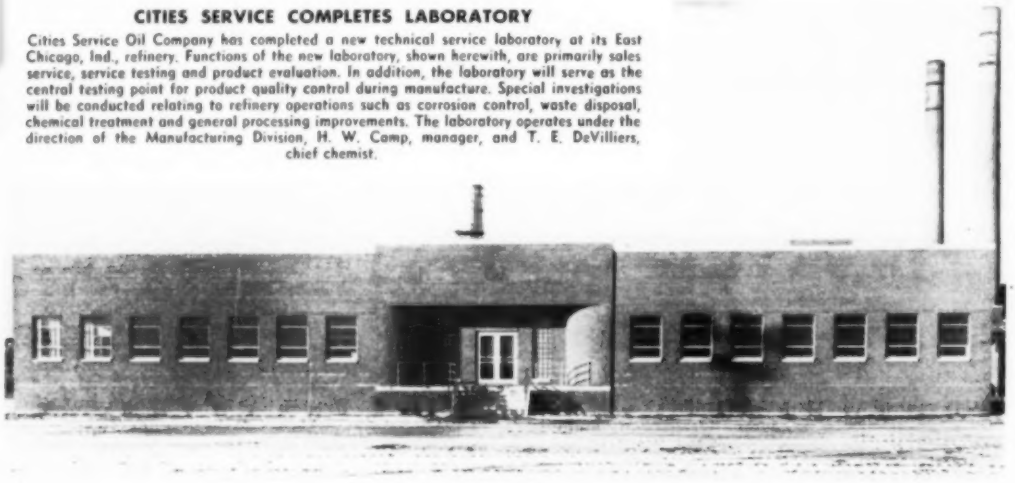
No "real shortages" of petroleum are anticipated during the next five years, Bureau of Mines Director Boyd told the House Appropriations subcommittee, but there is "danger of oil shortages over the long range" even if there is no war. "It does not seem possible that we will be able to maintain discovery of our natural liquid fuels at the rate at which the consumption is gaining so the synthetic fuels are eventually in the picture," he said.

Commenting on the synthetics program, Secretary of the Interior Krug observed that "the oil-shale process seems to be far enough along that private interests can try a commercial-sized plant. Within another year, the pilot plant work of the oil-from-coal process will be far enough along that we can start the actual construction of commercial-sized plants on at least one of the two methods."

Krug in his annual report said that undertaking the rapid development of a synthetic liquid fuels industry is the

CITIES SERVICE COMPLETES LABORATORY

Cities Service Oil Company has completed a new technical service laboratory at its East Chicago, Ind., refinery. Functions of the new laboratory, shown herewith, are primarily sales service, service testing and product evaluation. In addition, the laboratory will serve as the central testing point for product quality control during manufacture. Special investigations will be conducted relating to refinery operations such as corrosion control, waste disposal, chemical treatment and general processing improvements. The laboratory operates under the direction of the Manufacturing Division, H. W. Camp, manager, and T. E. DeVilliers, chief chemist.



THE MONTH...

necessity facing the U. S. today, and that "if private enterprise is unwilling to take the risk, the government must, investing whatever is necessary to push ahead with the program."

Krug also called for "a more rational use of our remaining supplies of natural oil on some new basis which will permit determining whether in a given instance oil, gas, coal or water will be used for energy."

Krug emphasized these matters: the alternative source of liquid fuel in natural gas, the lagging of the unitization of oil and gas fields behind the needs of the nation, and the nation's advantage in having the new tideland resource with "the end of our present supply of petroleum almost in sight."

ASLE Hears Earl Shaner; Kettering Receives Award

Highlight of the annual convention and lubrication show of the American Society of Lubrication Engineers, April 11-13 in New York, will be presentation of the, ASLE annual award, issued to the person contributing most to the advancement of scientific lubrication during the year, which will be made to Charles F. Kettering, vice president and director of research of General Motors Corporation.

During the five sessions of the convention, lubrication as a science will be discussed by 22 specialists.

Du Pont Joins Program At University of Chicago

E. I. Du Pont de Nemours and Company has become the seventeenth large industry to join University of Chicago's $12 million basic atomic and metal research program. Du Pont will pay $100,000 for a five-year membership in the Institute of Metals, one of three institutes in the peacetime research program established by the University two years ago.

In addition to Du Pont, other industrial members include United States Steel Corporation, Westinghouse Electric Manufacturing Company, Standard Oil Company (Indiana), Aluminum Company of America, Standard Oil Development Company of New Jersey, Pittsburgh Plate Glass Company, Sun Oil Company, Inland Steel Company, Shell Oil Company, Celanese Corporation of America, Crane Company and Bethlehem Steel Company.

"Best" Safety Record

The best safety record in the 18 year history of Stanolind Oil and Gas Company was set by employes during 1948. Working a total of over 14.7 million hours, employes had only 50 lost-time accidents during the year. This resulted in an accident frequency rate of 3.39 as compared with the company's previous record low of 5.09, established in 1946.

In 1947 Stanolind had a frequency rate of 5.14. The National Safety Council reported that in 1947 the petroleum industry as a whole had a frequency rate of 13.16.

Dr. Charles Smith Named to Staff of Ethyl Corporation

Dr. Charles L. Smith has been appointed to the staff of the product Development department of Ethyl Corporation, in New York, to assist in the development and application of various chemical products.

Smith

For the past four years, Dr. Smith has been technical adviser of the National Agricultural Chemicals Association, formerly the Agricultural Insecticide and Fungicide Association. He has also served as research entomologist at Rutgers University, manager of the Doggett-Pfeil Company, and chemist for Interstate Chemical Manufacturing Company. He is a graduate of Rutgers University where he received his bachelor of science, master of science and Ph.D. degrees.

Guy Tate Elected Chairman Oil Industry Committee

Guy Tate, vice president of Magnolia Petroleum Company, Dallas, has been elected chairman of the Gulf-Southwest Oil Industry Information Committee, which administers the industry's informational program in New Mexico, Texas, Arkansas, Louisiana, Mississippi and Alabama. Tate succeeded Fred F. Murray, Oil Well Supply Company president, who resigned after two years of service.

Named as vice chairman of the district committee were John P. Morgan, Sun Oil Company, Dallas, and C. J. Guzzo, Gulf Refining Company, New Orleans.

David Randolph Salmon has joined the staff of the Oil Industry Information Committee in New York as educational coordinator. He will work primarily with the OIIC's youth and education subcommittee and will serve as liaison man between the Institute and the nation's educators.

He was director of education and industry for the National Association of Manufacturers prior to his present appointment.

Bureau of Mines Dedicates Synthetic Plants on VE-Day

The Bureau of Mines will dedicate two new coal-to-oil demonstration plants on the anniversary of VE-Day, May 8, at Louisiana, Mo. First of their kind in this country, these plants are being erected at a combined cost of $15 million "to serve as a proving ground for American coals, equipment and processing methods." The plants will use two basic processes for converting American coals to oil: the direct hydrogenation or Bergius-I. G. Farben process and the gas synthesis or indirect Fischer - Tropsch process.

Flow Meter Service School

The second in a series of service schools on flow meters was held during February at the home office of The Hays Corporation, Michigan City, Ind. The first school was held at Philadelphia during the instrument show of the Instrument Society of America.

The February school was under the direction of David Kamalo, chief service engineer for Penn Industrial Instrument Corporation, Philadelphia, which manufactures Hays-Penn flow meters. About 50 service engineers from the mid-west group of Hays representatives, including those at the parent plant, attended.

Similar schools will be held in various sections of the country. In addition Hays is planning a series of sales clinics on its entire line with stress on the new line of electronic instruments. These schools will be inaugurated next fall.

Socony-Vacuum Merges Four French Subsidiaries

A new company, Socony-Vacuum Francaise, has been formed with headquarters at 46 Rue de Courcelles, Paris, France, as the result of a merger of Compagnie Industrielle des Petroles, Raffineries de la Vacuum Oil Company, Vacuum Oil Company S.A.F. and Compagnie des Huiles Sinco, all of which are wholly or partly owned by Socony-Vacuum.

The board of directors of Socony-Vacuum Francaise comprises Philip Berard, George Drouin, Admiral R. Fenard, G. E. Gravier and Arthur G. Reed.

J. V. Powell Appointed Oronite Development Head

Oronite Chemical Company has appointed J. V. Powell general manager of development, a new position to cover activities in product development, technical service, market research and engineering.

Powell

Joining Standard Oil Company of California in 1941 as an engineer, he came to Oronite, a California Standard subsidiary, in 1947 as an engineer in the product development division.

Born in Czechoslovakia, Powell was graduated from the Institute of Technology at Prague in 1938 with BS and EE degrees in electrical engineering. He took two years of graduate work in physics at Prague's Charles University, followed by further work at the University of California.

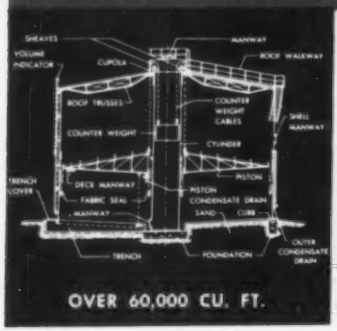
Dr. C. Rogers McCullough Awarded Merit Certificate

Dr. C. Rogers McCullough, of Monsanto Chemical Company's general development department, has been awarded the President's Certificate of Merit "in recognition of invaluable wartime scientific services."

A member of Monsanto's central research department during the war, Dr. McCullough directed various phases of rocket propellant and motors work for the National Research Defense Committee. He also worked for the Office of Rubber Reserve in the development of styrene.

Late in 1945, Dr. McCullough was appointed director of the power pile divi-

WIGGINS *Dry Seal* GASHOLDERS



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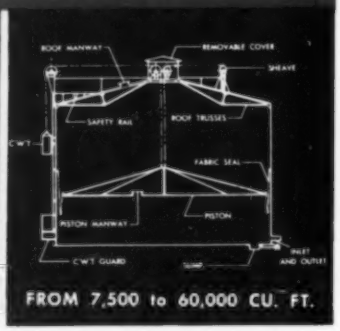

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THE MONTH...

sion at Oak Ridge, Tenn., where he began the development of industrial power from nuclear energy. He is now consultant to the group still engaged in this work. Dr. McCullough also contributed to the production of radioisotopes.

Standard (Indiana) Forms Whiting Science Club

Chemists and engineers of Standard Oil Company (Indiana), have formed the Whiting Science club, designed to broaden the technical background of its 350 members.

Hill

At meetings held five times yearly in the new research laboratory, scientists from the laboratories and refinery at Whiting, Ind., and the general office in Chicago hear addresses by authorities in various scientific fields. Recent speakers have been Dr. Ernest H. Volwiler, president-elect of the American Chemical Society, and Dr. Enrico Fermi, Nobel prize winner in physics. The program also includes lecture courses in such fields as petroleum technology.

Officers of the club are: Philip Hill, president; Howard Parker, vice president; and Marvin DenHerder, secretary-treasurer.

Directors for Little

Thomas K. Sherwood and Dr. Bruce S. Old have been elected directors of Arthur D. Little, Inc., Cambridge, Mass. R. C. Griffin has retired as director and as assistant secretary.

With the chemical engineering department of the Massachusetts Institute of Technology before being appointed dean of engineering in 1946, Sherwood is the author of many publications on chemical engineering subjects.

Dr. Old joined Arthur Little in 1946 after leaving the U. S. Navy as commander. He is in charge of process metallurgy, as well as being consultant to the Office of Naval Research and the Atomic Energy Commission.

Refinery Man Named

Charles W. Schaeffer, who retired in June, 1947, as manager of the Socony-Vacuum Oil Company, Inc., refinery at East Providence, R. I., has been named chairman of the board of managers of the East Providence branch of the Industrial Trust Company, succeeding the late Clarence H. Horton. Starting as an office boy in the Devoe Works, Standard Oil Company of New York, he became manager of the East Providence refinery in 1931.

AIChE Plans 4 Symposia

Program for the national spring meeting of the American Institute of Chemical Engineers, May 9-11, Mayo Hotel,

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Tulsa, has been arranged into four symposia plus one group of miscellaneous papers. Included in the symposia are Primary Energy, Chemicals from Petroleum, Oil and Gas Production and Chemical Engineering Economics.

Dr. Willard Dow Dies in Plane Crash in Canada

Dr. Willard Henry Dow, 52, president of The Dow Chemical Company, died March 30 in a plane crash near London, Ontario, Canada. Also killed were his wife; A. J. Bowie, pilot; Fred Clements, co-pilot; and Mrs. Calvin Campbell. Campbell, a director of the company, was the sole survivor of the crash.

Dow

Son of Dr. Herbert H. Dow, founder of the chemical company, Dr. Dow was graduated from the University of Michigan with a bachelor of science degree in 1919. The same year he began his career with Dow. In 1922 he was made a director of the company and assistant general manager in 1926. After his father's death in 1930, Dr. Dow took over duties of president and general manager, becoming chairman of the board in 1941.

R. L. Zimmerman Dies

Russell L. Zimmerman, refinery engineer and head of the thermal cracking department for Pan American Refining Company, Texas City, Texas, died March 6 at his home in Galveston. He was employed by Standard Oil Company (Indiana) before joining Pan American in 1934.

Instrument Society Plans Spring Meeting in Canada

The fourth spring meeting of the Instrument Society of America will be held May 12-13 at the Royal York Hotel in Toronto, Canada.

Bureau of Standards Adds Three Men to Its Staff

The National Bureau of Standards has added three men to its staff.

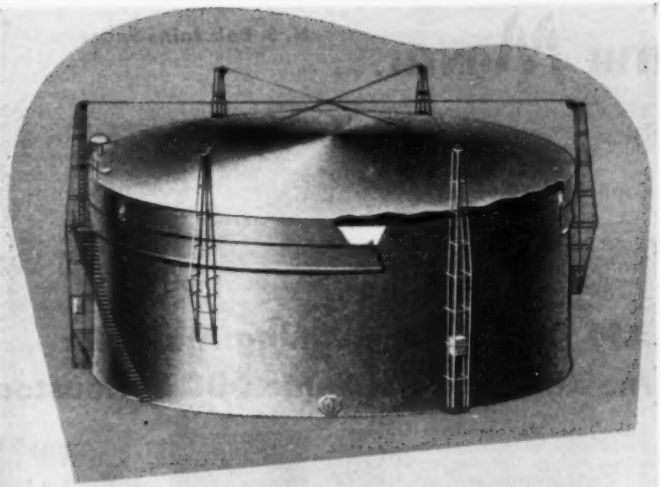
Charles A. Mabey to supervise electronic miniaturization, circuits and processes as assistant chief of the engineering electronics laboratory.

Dr. John R. Pellam to do research in the cryogenics laboratory, investigating the properties of liquid helium II.

Dr. Ralph L. Nuttall to do research on the thermal conductivity of gases at elevated temperatures and pressures in the thermodynamics laboratory.

Institute Names Mills

William H. Mills, formerly chief of the airport division of the Civil Aeronautics Administration at Atlanta, Ga., has been appointed district engineer of The Asphalt Institute in charge of the newly established Institute office in At-



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THE MONTH...

lanta. His territory includes Georgia, Florida, Alabama, Mississippi, Louisiana and Tennessee.

Council to Meet

The National Petroleum Council will hold its next quarterly meeting April 27 in Washington, according to Chairman Walter S. Hallanan.

H. S. Bell Joins Snare

H. S. Bell, formerly president of H. S. Bell, Inc., is now a member of Frederick Snare Corporation. A graduate of Princeton University, he was employed by Vacuum Oil Company (now Socony-Vacuum), Sinclair Consolidated Oil Company and The M. W. Kellogg Company, before organizing his own engineering company. Petroleum consultant to the United States Board of Economic Warfare in 1942-43 and a member of the United States Joint Petroleum Board Mission on Oil Shale to Australia in 1943-44, he is the author of several technical papers.

API Division of Refining Mid-Year Meeting Attracts Some 600 to Houston

More than 600 refining industry personnel were in attendance at the 14th annual mid-year meeting of the American Petroleum Institute held April 4-7 in the Shamrock Hotel, Houston, a meeting devoted to discussions of rapid methods of analysis, corrosion, vapor-lock, refinery maintenance, waste disposal, and employe training. More than 30 papers were presented at the seven group sessions and 29 committees and sub-committees also held meetings.

Presented at the meeting were Certificates of Appreciation to Walter Samans, Sun Oil Company; Kenneth G. Mackenzie, The Texas Company, Thomas G. Delbridge, retired, The Atlantic Refining Company, outstanding petroleum technologists, for their contributions to refining and standardization. The certificates, first to be presented by the API, were made at a dinner session by John W. Newton, vice president, Magnolia Petroleum Corporation, Beaumont, Texas, vice chairman of the general committee.

Chester F. Smith, Standard Oil Company (New Jersey), New York and API vice president for refining, addressed the dinner meeting on "The Future of Oil Refining." He predicted that refiners will be concerned with three main problems in the futre: "improvement in quality of gasoline and lubricating oils; increase in the yields of the middle distillates, with the more intensive processing of residual fuel oil an important part of this; and production of an increasing number of new products." This country's large supplies of residual fuel oil should be considered first as a better potential source of light products than establishment of a synthetic fuel industry at the present time, he said.

Smith also told the assembly that refining operations will increase in complexity and in flexibility because of the variety of products and because many products are the result of highly involved processes.

Osborn Is Speaker

Harold G. Osborn, vice president of Continental Oil Company, Ponca City, Okla., told the dinner group that there are "two means by which management can help labor be worthy of its hire, and simultaneously improve the earnings of its shareholders and the standard of living of rank-and-file employees." His topic was "Helping Labor Be Worthy of Its Hire." "The two means," he said, "are simply the reduction of grievances by the selection and training of foremen who can express themselves understandably, and who like people; and the application of well-known engineering principles to the performance of work of the rank and file, to the end that they become dignified, independent merchants of their services—engaged in free enterprise—rather than servers of time for a specified wage." Selection and training of foremen, he told the group, would partly eliminate the lost motion and lowered worker efficiency brought about by grievances.

T. G. Delbridge

Walter Samans

K. G. Mackenzie

Much time should be taken to study each and every job, Osborn said, in discussing his program of industrial engineering, so that established norms are accurate and honest, and are not "stretch outs." Employes must be "sold" on the program so they will cooperate. With the application of a wage-incentive program, Osborn continued, productivity would be improved, and at the same time the earnings of the shareholder and the employee alike would be increased. He said he is convinced that the refining industry should embrace industrial engineering now with the same alacrity and vision that it has ever other promising technological development.

The first two group sessions of the meeting were devoted to the continuation of the symposium on rapid methods of analysis, which was held originally at the 28th annual meeting in Chicago last November. Widespread interest made the additional sessions at the mid-year meeting advisable. J. B. Rather, Jr., Socony-Vacuum Oil Company, Inc., Brooklyn, and W. D. Seyfried, Humble Oil & Refining Company, Baytown, Texas; presided at the two sessions.

Employe training was the subject of another group session, Sterling W. Mudge, Socony-Vacuum Oil Company, Inc., New York, presiding. Harry D. Kolb, chairman of the API Committee on Training in Refining, said the survey of training practices brought forth a challenge to the industry. Many plants, with inadequate or no such programs explained the inaction as a result either of lack of knowledge of techniques to use or lack of manpower to do the job. "If training techniques are sound, the results should so far outweigh the cost that management would feel it could ill afford not to provide such training service," Kolb declared.

F. W. McCurry, The Derby Oil Company, Wichita, Kan., presided at the corrosion group session. One of the several interesting papers here was on hydrogen blistering, a report compiled by M. H. Bartz and C. E. Rawlins, Phillips Petroleum Company, Bartlesville, Okla.

The symposium on vapor-lock problems found David E. Day, Richfield Oil Corporation, Los Angeles, presiding. Three addresses were given.

E. B. McConnell, The Standard Oil Company (Ohio), Cleveland, presided over the management of refinery maintenance group. (One of the papers read here, "Maintenance Shops: The Layout and Tooling" by Ditmas Bromley and Henry P. Evans, C. F. Braun and Company, Alhambra, Calif., appears starting on page 167.) Preventive maintenance, lowering maintenance costs by better scheduling and control of maintenance costs were other subjects discussed.

The final group session was on waste disposal with C. E. Davis, Shell Oil Company, Inc., New York, presiding.

Dr. Thomas G. Delbridge retired from The Atlantic Refining Company in 1947 after 38 years with the company. He was manager of the research and development department, which he assisted in organizing. Extremely active in the refining industry committees and associations he also served in petroleum wartime committees. Among his favorite topics was the "importance of analytical methods" in technological development. He always advocated proper recognition of the analytical chemist.

Kenneth Gerard Mackenzie is widely known for his work in organizing and directing continuous efforts to standardize testing procedures and criteria. He has devoted himself to the development and universal acceptance of valid scientific methods in evaluating petroleum and petroleum products characteristics. With The Texas Company since 1911, Mackenzie plans to retire from the company "in a few years."

Walter Samans believes that many jobs in oil refineries would be safer if everyone knew a lot more about corrosion and the design of pressure vessels. Since 1921 his interest has been in standard codes and specifications for construction of steel pressure containers. He joined Sun Oil Company in 1937 as mechanical and administrative engineer. Previously, he had been chief engineer of The Atlantic Refining Company. Samans has been the driving force in numerous API committees and in technical societies.

BOOKS

Bureau Offers Charts on Gas Compressibility Factors

A set of charts of compressibility factors for hydrogen, nitrogen and oxygen, together with charts showing quantities of these gases delivered by commercial cylinders, has been published by the National Bureau of Standards.

Three of the charts give the number of standard cubic feet of gas which a commercial cylinder will deliver. The remaining three give the compressibility factor $Z = pV/nRT$. The pressure range of these charts is from 0 to 6000 psi. at from —50° F. to 150° F. The commercial cylinder charts cover temperatures between —10° F. and 130° F. and a pressure range between 1300 and 2800 psi. A brief text is supplied, containing a table of gas-cylinder sizes and several examples of the solution of practical problems by use of the chart.

Miscellaneous Publication M191 may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. for 25 cents per copy.

Foundation Has Available New Arc Welding Book

A record of the progress of arc welding during the postwar years is contained in the new book, *Design for Welding*, published and available from the James F. Lincoln Arc Welding Foundation, Cleveland 1, Ohio. Price is $2, postage prepaid, in the United States and $2.50 elsewhere.

The book is composed of abstracts of 82 award papers in the recent Foundation "Design-for-Progress" award program. Papers included in the book are classed into the following categories: aircraft, automotive, railroad, watercraft, containers, furniture, structures, machinery and welderies.

Technical Catalog Compiled By Reinhold Corporation

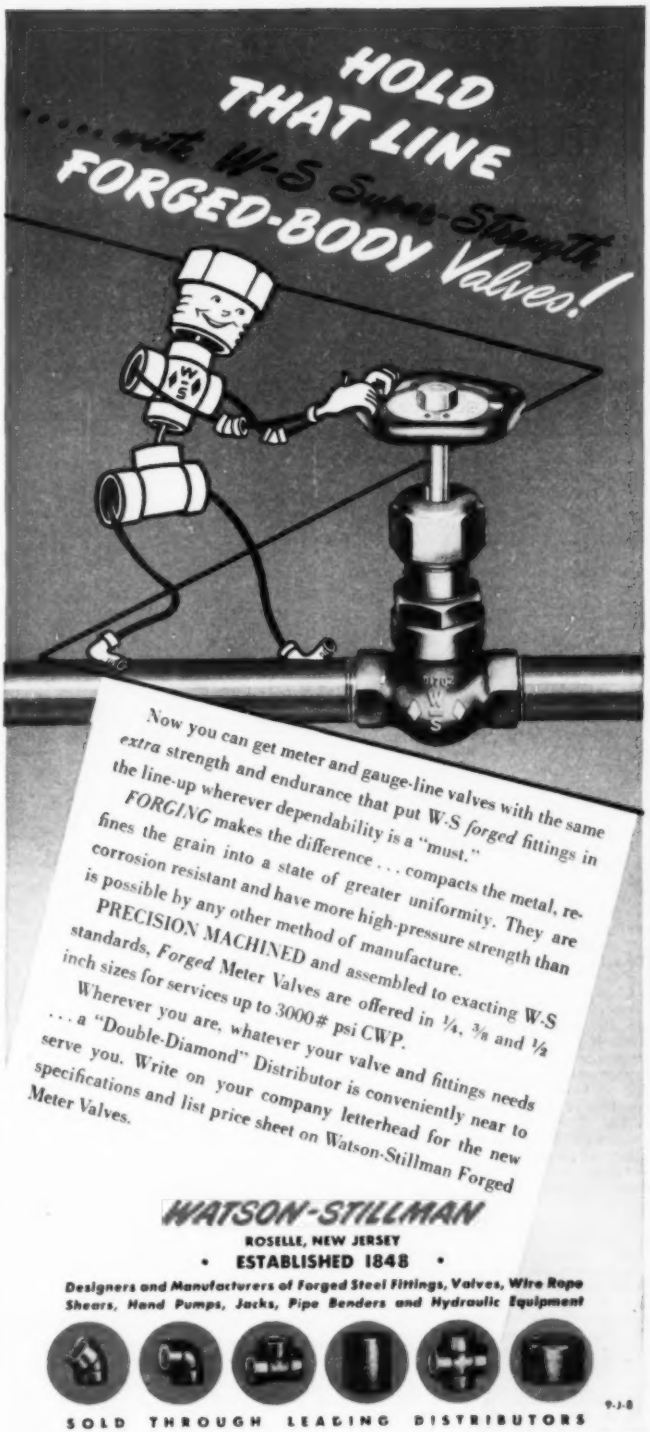
Reinhold Publishing Corporation has compiled a 1949 catalog of technical books the company has in publication. It describes the latest books in the fields of agricultural chemistry, biochemistry, chemical engineering, industrial chemistry, colloid chemistry, drugs and medicine, fats, oils and waxes, food and nutrition, metallurgy and metal-working, organic chemistry, paint, varnish and ink, petroleum, physics, plastics, rubber and gums, textiles and process industries products.

For a copy of this catalog write Reinhold Publishing Corporation, 330 West 42nd Street, New York 18.

Hydraulic Standards Issued

The eighth edition of the Standards of Hydraulic Institute includes a general section and a data section as well as sections on centrifugal pumps, rotary pumps and reciprocating pumps. A new section, Tentative Standards on Pipe Friction, has been added. Test codes of the pumps are given.

Address Hydraulic Institute, 90 West Street, New York 6. ($3 per copy.)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SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

These abstracts are selected from the current literature of science and technology, not including trade journals easily available. Photostatic copies of original articles will be supplied at cost by The Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, also will be prepared and furnished by arrangement with the Laboratories.

Manufacture: Processes and Plant

Liquid Flow Conditions in Packed Towers. S. S. GRIMLEY, *Trans. Inst. of Chem. Engrs*, **23** (1945), pp. 228-35.

The flow of liquids on vertical surfaces was studied with particular reference to liquid behaviour in packed towers and similar contacting equipment. Significant departures from the predictions of streamline flow theory were studied and has been related to wetting and channeling tendencies in packed columns, as typified by the behaviour of ¼-inch rings in a laboratory column. Photographs of liquids of different Reynolds number flowing over vertical surfaces are presented.

The Fractionation of Binary Mixtures in a Wetted-Wall Column. J. ANDERSON STORROW, *Trans. Inst. of Chem. Engrs.* **23** (1945), pp. 32-42.

The fractionation of binary mixtures in a wetted-wall column was studied to ascertain the applicability of:

1) counter-current diffusion concept to the process,

2) the correlation of the resistance to diffusion, expressed as an effective film thickness, in terms of suitable dimensionless groups including those operating conditions and physical characteristics of the system presumed to be important.

Use of the measurement of the vapour temperature as an analytical technique for the determination of composition made it possible to obtain approximate measurements of the gradient of the concentration curve directly. The use of this technique allows estimation of the effective film thickness at particular vapour compositions, which is not possible with the measurement of composition changes over long columns as hitherto reported. The results obtained show an approximate correlation within the limits commonly noted in similar work and agreeing with relations found in uni-directional diffusion. The technique employed has detected variations of effective film thickness with vapour composition which suggest either that the diffusion equations are inadequate or that unexpected variations occur in the physical properties of the binary mixtures. A bibliography of 36 references is included.

Pure Hydrocarbons from Petroleum. Preparation of Methylcyclohexane from Straight-Run Heptane Fraction. JOHN GRISWOLD AND J. W. MORRIS, *Ind. Eng. Chem.* **41** (1949), pp. 331-6.

Methylcyclohexane of high purity was prepared from a narrow-boiling straight-run fraction by four successive operations: 1) a continuous fractionation to remove the material boiling below n-heptane; 2) a solvent fractionation to eliminate nearly all of the heptane with the remainder of the lighter materials; 3) a second solvent fractionation to eliminate the toluene with part of the higher naphthenes; and 4) a batch fractionation to recover methylcyclohexane of a purity of approximately 99 mole percent. An improved pilot plant is described and structural details are presented. The data secured in the course of the work are presented in some detail in tabular and graphical form.

Mercaptan Formation in Acid Treatment of Pressure Distillate. C. R. WILKE AND WILLIAM JAMES WRIDE, *Ind. Eng. Chem.* **41** (1949), pp. 395-9.

It was found that appreciable quantities of mercaptans are formed in the acid treatment of pressure distillate containing hydrogen sulfide. It is indicated that hydrogen sulfide adds to olefins in the presence of acid acting as a catalyst. Mercaptan formation as high as 969 mg. of sulfur per liter occurred in pressure distillate initially containing 1430 mg. of hydrogen sulfide per liter during treatment with 5 pounds of 87.4 percent sulfuric acid per barrel. Formation of disulfides was also observed. Similar results were obtained with caprylene-Skellysolve mixtures. The effects of temperature, acid strength and acid quantity were studied over a range of conditions used in commercial practice. The removal of hydrogen sulfide prior to acid treatment is indicated. A bibliography of 16 references is included.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

Di-n-decyl amine
n-Triacontanol
Pentadecanal
n-Octacosanol
3-(2-Mercaptobenzothiazyl) propionic acid
2,5-Dimethylresorcinol
1-Butyne-3-ol
Carene
2,2-Dibromopropane
1,1-Dibromopropane
p-Menthane
2-Ketostearic acid
9-Ketostearic acid
10-Ketostearic acid
18-Hydroxystearic acid
3-Methyl-2, 3-Dihydropyrrole
Neomenthol
2,4-Dimethyl-5-phenylthiazole
3-(Hydroxymethyl) indene
n-Docosanal
4-Phenoxycatechol
4-Methoxycatechol
1-Pentenyl-1-acetate

Heat of Cracking and Regeneration in Catalytic Cracking. J. C. DART AND A. G. OBLAD, *Chem. Eng. Progress* **45** (1949), pp. 110-18.

The heat of reaction in once-through catalytic cracking at 850° F. of an East Texas gas oil varied from +100 Btu per pound of charge at 35 percent conversion to +118 Btu per pound at 55 percent conversion. Above 55 percent conversion the heat of cracking decreased with an increase in conversion to a heat of reaction of +45 Btu per pound of charge at 80 percent conversion. An increase in average reaction temperature from 850° to 900° F. at constant conversion was found to have no effect on the heat of reaction. The heat of cracking expressed as Btu per pound of product was found to decrease with an increase in conversion. The heat of cracking was endothermic to the extent of +280 Btu per pound of product at 35 percent conversion and decreased uniformly to about +50 Btu per pound of product at 80 percent conversion. The heat of combustion of the catalyst residue was estimated to be —16,740 Btu per pound of residue. Heat of combustion of the carbonaceous catalyst deposit was calculated to be —13,950 Btu at 1000° F. and for CO_2/CO ratio of 2 in the flue gas.

Regeneration Characteristics of Clay Cracking Catalyst. J. C. DART, R. T. SAVAGE AND C. G. KIRKBRIDE, *Chem. Eng. Progress* **45** (1949), pp. 102-10.

Investigations show that the primary variables in the regeneration of clay cracking catalysts are instantaneous carbon content, combustion temperature and oxygen partial pressure. At carbon content less than 2 percent, burning rate is of second order dependency on carbon content and of first order depend-

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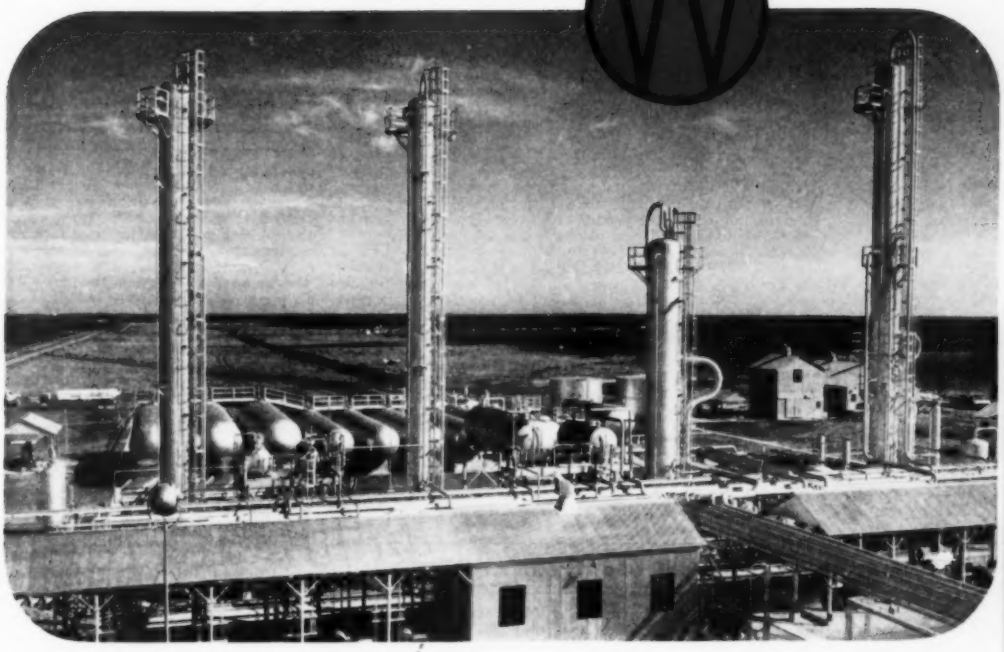

WARREN PETROLEUM CORPORATION

Western Heat Transfer Equipment plays an important role in the manufacture of stabilized natural gasoline at Warren Petroleum's Holliday, Texas plant, pictured above. Close attention to detail and specification from design to installation is the prime consideration in the manufacture of all Western equipment for gasoline plants, refineries, chemical processing plants and pipelines throughout the world.

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ency on oxygen partial pressure. A single algebraic equation was developed involving only the three primary variables to obtain the instantaneous carbon burning rate at any design condition. From the relationship between the fraction of hydrogen burned and the fraction of carbon burned the coke burning rate can be calculated. The rate controlling step in the regeneration of pelleted clay cracking catalyst is the rate of a chemical reaction, or reactions, involved in the combustion process. Gas diffusion can, however, be one of the factors that modifies the rate of carbon burning in other types of catalysts that have different diffusional properties.

Economics of Moving Bed Catalytic Cracking Processes. T. A. Burtis, J. C. Dart, C. G. Kirkbride and C. C. Peavy, *Chem. Eng. Progress* **45** (1949), pp. 97-101.

The paper presents an economic comparison of the conventional moving bed Thermofor catalytic cracking process and the recently developed Houdriflow moving bed catalytic cracking process. The high catalyst-to-oil ratio of the Houdriflow design results in a substantial saving in investment, utility and maintenance costs. Although catalyst attrition rates will be lower in the Houdriflow design, actual catalyst losses may be somewhat higher depending upon the catalyst-to-oil ratios chosen. It is believed that the high catalyst circulation units will prove more profitable than the conventional TCC units. Savings to be realized with the Houdriflow system are a direct function of catalyst circulation rate. If design conditions could be maintained permanently, a completely heat-balanced unit would be most profitable. However, because of almost certain changes in processing needs, it would be desirable to insure flexibility by providing nominal feed pre-heat and catalyst cooling capacity.

An Automatic Indicator for Coloured Fuels Flowing in a Pipeline. J. Savage and M. Squires, *Jour. Inst. of Petroleum* **34** (1948), pp. 878-87.

In oil-pipeline operation several grades of fuel may be run through the line successively. Duration of the period of change-over from one fuel to another at the receiving point depends upon many factors, and is of the order of 5 to 10 minutes. This change-over period is characterized by a mixture of two fuels passing in the pipeline, and it is frequently undesirable that a large proportion of this mixture should be run into either of the tanks receiving the separate fuels. A method of warning the operator when a change-over of fuels is occurring is therefore required. An instrument was developed that gives an automatic indication of a change in the colour of a liquid flowing in a pipeline. Use is made of differences in light absorption of differently coloured liquids. The method is capable of wide application where two liquids of different colours are concerned. A small quantity of fuel from the pipeline is run through a pressure-reducing valve into an absorption tube, that forms part of an optical pipeline unit. A beam of light is passed through the tube, and falls on a photocell system, the output of which is fed into a triggering circuit, which forms the basis of the indicator. Electro-magnetic relays, operated by the triggering circuit, actuate the warning lights and audible alarm.

Fundamental, Physical and Chemical Data

Prediction of p-V-T Properties of Gases from Critical Data. Joseph Joffe, *Chem. Eng. Progress* **45** (1949), pp. 160-6.

Although significant progress has been made in the prediction of p-V-T properties of gases from generalized equations, generalized graphical correlations such as z-charts are at present more widely applicable than analytical methods to problems of engineering interest. Gas mixtures are handled most conveniently by the pseudo-critical method, using certain rules, such as Kay's relations, to calculate the pseudo-critical constants of the mixture from the critical constants of the pure components. These rules must be used with caution in gaseous systems in which the forces of interaction between unlike molecules are of a different nature than forces operating between like molecules. A bibliography of 51 references is included.

The Cryoscopic Behavior of 1,1-Dimethylcyclohexane Containing Certain Hydrocarbon Impurities. G. L. Evans, K. F. Greenlee, J. M. Derfer and C. E. Boord, *Jour. Am. Chem. Soc.* **71** (1949), pp. 361-2.

The study was prompted by the observation that introduction of a small amount of cis-1,2-dimethylcyclohexane as an impurity in 1,1-dimethylcyclohexane caused an increase in the freezing point of the latter hydrocarbon, instead of the normal lowering. Although similar irregularities caused by solid solution formation have been observed for several binary hydrocarbon systems, it was thought that this new information would prove helpful because of the widespread reliance on cryoscopic data as criteria of purity. Data are presented in some detail in tabular form of the solutes used only in heptane and n-butylcyclohexane produced normal freezing point lowering. Ability to form mixed crystals or solid solutions is common to all hydrocarbons that have low heats and entropies of fusion. Such molecules rotate in the solid phase below their melting points and possess considerable mobility of structure, enabling solute molecules of similar size and shape to be accommodated in the crystal lattice without fusion of the crystal. It is the over-all size and shape of the molecule rather than its molecular species that determines whether or not a solid solution will result.

Low Temperature Vapor-Liquid Equilibria. Part 1, Phase Equilibria in Natural Gas at Low Temperatures. Leroy F. Stutzman and George Martin Brown, *Chem. Eng. Progress* **45** (1949), pp. 139-48.

Part I of the paper deals with phase equilibria in natural gas at low temperatures. Vapor-liquid phase equilibria for the common components of a natural gas were determined experimentally by a flow process. Experiments were made at a total pressure of 100 pounds per square inch absolute and temperature was varied from —130° F. to —240° F. Equilibrium cell and its contents were maintained at low temperatures by means of liquid nitrogen. Experimental equilibrium constants were compared with a correlation obtained from other data available in the literature. Part II of the paper deals with equilibrium constants for nitrogen, methane and ethane at low temperatures. Vaporization constants are presented for these gases for the temperature range —360° F. to +240° F. at pressures up to 1000 psia. The correlations are presented in the form of simple equations and are reasonably accurate for pressures below 0.2 times the convergence pressure. A bibliography of 54 references is presented.

Products: Properties, Utilization and Analysis

Polyform Distillate. W. C. Offutt, M. C. Fogle and Harold Beuther, *Ind. Eng. Chem.* **41** (1949), pp. 417-23.

A more comprehensive knowledge of the properties of gasoline used in blending motor fuels that meet increasingly rigid specifications is highly desirable. The authors present representative data on the physical properties and characteristics of Polyform distillate and make general comparisons with gasoline distillates from other refining processes. Many of the physical properties and characteristics of Polyform distillate can be attributed to the operating conditions in the Polyform process—high pressures, high temperatures and cracking in the presence of recirculated C_3 and C_4 gases. Polyform distillates have high over-all volatility; they contain more low boiling and less high boiling material than most gasolines from other processes. Polyform distillates are rich in low boiling olefins, lean in high boiling olefins and rich in aromatics. They have high octane numbers with excellent blending values and good road performance. In addition, Polyform distillate can be catalytically treated to produce a good aviation base stock. Polyform distillate is compared with straight-run, thermally cracked and catalytically cracked gasolines with respect to chemical analysis and actual road performance. A bibliography of 7 references is included.

Knock in Internal Combustion Engines. R. W. Wheeler and D. Downs, *Nature* **162** (1948), pp. 893-4.

There is evidence that formation of peroxides in the last part of the charge in spark ignition engines is connected with knocking. The authors determine total peroxide and also aldehyde. An electromagnetically operated valve was used that permitted removal of gases from an engine cylinder over a narrow crank period. Gas samples were removed from the knocking zone. Organic peroxide and hydrogen peroxide were determined in the gases. Nitrogen dioxide and olefins were removed by passing the sampled gas through a solution of sulfamic acid and treatment with bromine under conditions to minimize the loss of peroxide by interaction with the bromine. When iso-octane was used as fuel the engine did not knock, but at a compression ration of 9.9 a heavy knock occurred. It was found that a rise in the preflame peroxide concentration takes place prior to "top dead center", followed by a much higher peak just before the flame. At increased compression ratio, an earlier rise in peroxide concentration and a much higher peak value

were found. Aldehyde curves rise smoothly up to the time of flame arrival to a peak concentration some 30 times greater than the peak value for peroxide. Tetraethyl lead decreases aldehyde concentration at all times.

Viscosity-Temperature Characteristics of Hydrocarbons. R. T. SANDERSON, *Ind. Eng. Chem.* **41** (1949), pp. 368-74.

The purpose of the paper is to present a method for evaluating viscosity-temperature properties and to discuss some useful applications of the essential principles to some pure hydrocarbons and to lubricating oils. The viscosity-temperature curves are compared using the same viscosity limits instead of the same temperature limits as is the customary procedure. A simple means of making such a comparison is by use of a kinematic viscosity-temperature number (VTN). This is defined as a number equal to the temperature span, in °F., between two fixed viscosities, here arbitrarily chosen as 2 and 100. Simple relationships among viscosities (VTN) and molecular weights of homologous compounds are presented. The effect of structure on viscosity-temperature relations of pure hydrocarbons is evaluated by VTN. Methods of applying the same basic principle to calculating viscosities of multi-component mixtures and of oil viscosity index improvers are described. Data are presented in considerable detail in tabular and graphical form and a bibliography of 11 references is included.

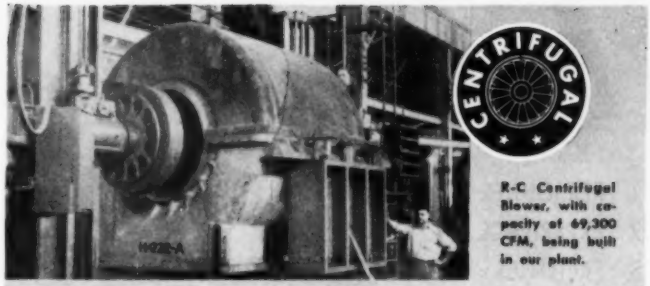
Chemical Composition and Reactions

A New Synthesis of Monoalkylcyclobutanes: Reduction of Neopentyl Type Tribromides. JOHN M. DERFER, KENNETH W. GREENLEE AND CECIL E. BOORD, *Jour. Am. Chem. Soc.* **71** (1949), pp. 175-182.

The general procedure followed in the investigation was to prepare neopentyl type tribromides from the corresponding trihydric alcohols and to treat them with zinc by the Haas-McBee procedure. Alkylidenecyclobutanes are formed in about 50 percent yield and these can be hydrogenated to the corresponding alkylcyclobutanes. The procedure furnishes a general and practical method for the preparation of monoalkyl cyclobutanes, with a possible exception of methylcyclobutane. Reaction mechanisms, based on well recognized theories, are proposed to account for all of the products identified.

The Catalytic Hydrogenation of the Benzene Nucleus. IV. The Hydrogenation of Methyl-substituted Benzoic Acids. HILTON A. SMITH AND JAMES A. STANFIELD, *Jour. Am. Chem. Soc.* **71** (1949), pp. 81-3.

A study was made of the kinetics of catalytic hydrogenation of a number of methyl-substituted benzoic acids. The reactions were effected at low pressures, in acetic acid solution, using Adams platinum catalyst. First-order reaction rate constants, all referred to one gram of standard platinum oxide, are given. Substitution of a carboxyl group for a methyl group was found to cut the rate of hydrogenation in half. It was also found that compounds with symmetrical substitution generally hydrogenate more readily than corresponding unsymmetrically substituted compounds.



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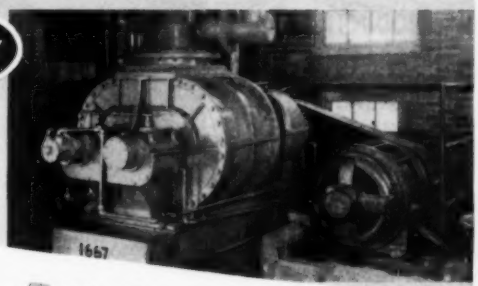

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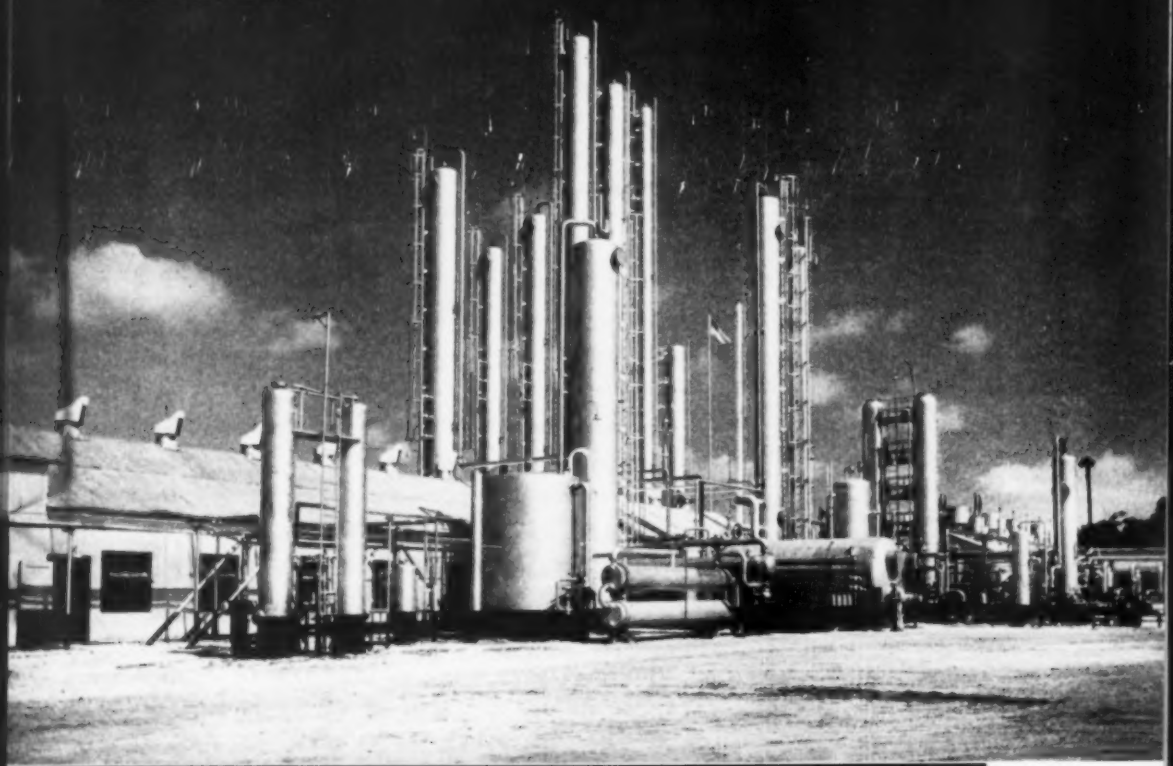

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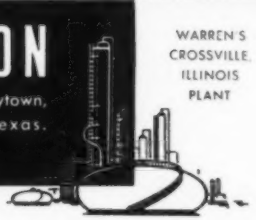

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(From the Official Gazette, January 11, 18, 25 and February 1 and 8, 1949)

CATALYST PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,457,566. Regeneration of Alumina Adsorbents by Oxidation. K. A. Krieger and H. Heinemann to Porocel Corporation.

The process claimed in U.S.P. 2,457,556 is used for regenerating spent alumina.

U.S.P. 2,458,378. Process of Separating Metallic Sodium from High Molecular Weight Polymers Made by Polymerization of Vinyl Compounds. G. Herbolsheimer to Phillips Petroleum Company.

To separate metallic sodium from a copolymer of 1,3-butadiene and styrene, or other unsaturated hydrocarbon polymers, in the production of which it was used as a catalyst, the copolymer containing sodium is cooled to a temperature not above —70° F. and then disintegrated, so that the individual particles of metallic sodium contained therein are exposed. The disintegrated mass is reacted with a sodium reactant, such as methyl alcohol, and the resulting sodium reaction product is separated.

U.S.P. 2,459,474. Process Utilizing Moving Solid Catalyst. J. D. Upham to Phillips Petroleum Company.

In order to prevent in a catalytic conversion process erosion and corrosion of portions of the apparatus caused by action of a moving powdered porous catalyst prepared from a silica hydrogel activated with minor amounts of alumina, while maintaining a desired constant level of catalytic activity, a silica hydrogel is applied under 1000 pounds pressure to the surface of the apparatus. This hydrogel shall have a substantially higher silica content than that used for the mobile catalyst, and shall be activated with minor amounts of alumina. After application the material is slowly heated to a temperature above that employed in the conversion operation. A hard, dense compact protective coating is thus produced which has little catalytic activity at the surface compared to that of the mobile catalyst, but has substantial activity when comminuted. The protective coating is abraded by the movement of the powdered catalyst to an extent sufficient to provide at least a portion of the make-up powdered catalyst required.

U.S.P. 2,459,531. Catalyst Absorption. E. K. Jones to Universal Oil Products Company.

An apparatus is claimed which makes it possible to recover the relatively small portion of a catalyst entrained in the reaction products stream of a conversion process, e.g. HF entrained with the products of a hydrocarbon alkylation. The mixture containing the entrained catalyst material in liquid phase is passed from a zone of relatively high pressure to a zone of relatively low pressure, and the vapors thus released and containing the entrained catalyst are conducted to an absorption zone.

U.S.P. 2,459,903. Catalyst Gels. V. Voorhees to Standard Oil Company (Indiana.)

Spheroidal particles of an inorganic oxide hydrogel with a strong agglomerating tendency are suspended in a water-immiscible hydrocarbon liquid maintained at a temperature at which water exerts a substantial vapor pressure, e.g. at 150-400°F. Water vapor is removed from this suspension by injecting a desiccating gas. The water content of the gel particles is thus reduced to a point where agglomeration ceases. The gel is then separated from the hydrocarbon liquid.

U.S.P. 2,459,987. Mixed Silica-Alumina, Silica-Magnesia Catalyst. J. P. Bilisoly to Standard Oil Development Company.

A cracking catalyst consists essentially of a mixture of 80-85 percent SiO_2-MgO and 20-15 percent of a separately prepared SiO_2-Al_2O_3. The first named compound contains 30-35 percent MgO and 70-65 percent SiO_2, and the second 50-65 percent Al_2O_3 and 50-35 percent SiO_2. The new catalyst is relatively steam stable. The admixture of the two components of the catalyst can be effected in the dry or in the hydrogel state.

U.S.P. 2,460,333. Preparation of Dehydrogenation Catalysts. J. G. M. Bremner, P. W. Reynolds and A. W. C. Taylor to Imperial Chemical Industries, Ltd.

An aqueous solution containing an Al-salt and ammonium dichromate, or ammonium chromate, or CrO_3 is mixed with ammonia, or ammonium carbonate or bicarbonate to completely precipitate the aluminum. The resulting precipitate is subjected in unwashed state to cautious thermal decomposition (e.g. by carefully heating at about 120°C. after drying). The decomposed product is blended with 0.05-5 percent sodium, potassium, or zinc chromate, zinc dichromate, or zinc chromite. A dehydrogenation catalyst is obtained.

U.S.P. 2,460,811. Process for Preparing Pelleted Iron Oxide Type Catalysts. E. P. Davies and F. T. Eggertsen to Shell Development Company.

Powdered iron oxide is mixed with water to form a moist mass which upon normal extrusion forms pellets sticking together upon contact but sufficiently stable to hold their shape temporarily. The moist mass is rapidly dried on its surface during extrusion to below the point of stickiness. The extrudate which has a higher percentage of water content in its interior than on the surface is cut within 5 seconds of its formation into lengths suitable for catalytic pellets, and then completely dried. Highly porous pellets are obtained.

U.S.P. 2,461,343. Contacting Gaseous Fluids and Solid Particles. H. J. Ogorzaly and A. Voorhies, Jr. to Standard Oil Development Company.

Spent solid catalyst particles containing entrained gaseous hydrocarbon fluid are withdrawn as a dense fluidized mixture from a contacting zone and intimately mixed with a stripping gas in the bottom portion of a stripping zone to change said fluidized mixture into a dilute suspension of the solid particles in the stripping gas. Further details are claimed for purging the catalyst particles.

CRACKING AND REFORMING

U.S.P. 2,459,056. Gas-Solid Contacting Apparatus. K. M. Watson to Sinclair Refining Company.

An apparatus is claimed for contacting a granular solid with an aeriform fluid, particularly for catalytically cracking hydrocarbons in vapor phase and for regenerating catalyst from such process. Non-uniform upward flow of the reactant fluid across the reaction chamber through the granular solid, the so-called "channeling," is reduced by arrangements made in this apparatus.

U.S.P. 2,459,425. Apparatus for Contacting Gaseous Fluids with Solids. C. E. Hemminger to Standard Oil Development Company.

Granular catalyst is moved upwardly through a vertical cracking zone by means of a conveyor while oil vapors are countercurrently passed through this zone. The contaminated catalyst is discharged and passes downwardly through a regeneration chamber which comprises a plurality of vertical ducts disposed between baffled flues. The walls of these

ducts are perforated to permit the regenerating gas to flow into and out of the ducts.

U.S.P. 2,459,480. Method of Conditioning a Catalyst for Use in Hydroforming of Naphthas. A. B. Welty, Jr. and C. H. Holder to Standard Oil Development Company.

A virgin naphtha is hydroformed in the presence of free hydrogen by means of a catalyst which consists of an oxide of a heavy metal of groups V and VI of the periodic system, carried on a support. This catalyst is subjected before use to a series of about 720 cycles of oxidation and reduction at elevated temperature.

U.S.P. 2,460,200. Thermal Conversion of Hydrocarbons. C. M. Thacker and H. O. Folkins to The Pure Oil Company.

Hydrocarbon oils are cracked at temperatures of 650-1200°F. in the presence of 0.05-3.0 mol percent of ethyl hypochlorite. Gasoline is obtained. Higher yields of cracked products are obtained at lower temperatures by addition of the explosive hypochlorite.

U.S.P. 2,460,404. Catalytic Conversion of Hydrocarbons. J. W. Ward to Universal Oil Products Company.

Subdivided solid catalyst is successively passed through at least three reaction zones maintained under cracking conditions. A hydrocarbon distillate comprising gasoline fractions is passed through these zones, while a hydrocarbon charge oil heavier than gasoline is introduced to and substantially cracked in the last zone. Vaporous conversion products of the distillate and charging oil removed from the last zone are fractionated to condense and separate fractions heavier than gasoline. At least a portion of these fractions is introduced for further cracking into an intermediate zone.

U.S.P. 2,460,463. Process for the Noncatalytic Cracking of a Hydrocarbon Oil. J. W. Loy to Phillips Petroleum Company.

Hydrocarbon oil is noncatalytically heated to cracking temperature. After reducing the pressure on the heated oil, it is introduced tangentially and at high velocity into a cylindrical separation zone which is closed at its top. Vapors and residual liquid are rapidly separated here by centrifugal force. The separated products are passed downwardly into an enlarged reaction zone surrounding and extending beyond both ends of the separation zone. While residual liquid is removed from the bottom of the reaction zone, the vapors are passed upwardly at low velocity around the separation zone into the upper portion of this reaction zone, where they are subjected to more complete cracking.

U.S.P. 2,461,069. Simultaneous Catalytic Cracking and Desulfurization of Hydrocarbons. M. M. Marisic, A. C. Schmitt and F. C. Frank to Socony-Vacuum Oil Company, Inc.

Vapors of a high sulfur-content petroleum hydrocarbon stock are contacted in the absence of hydrogen under cracking conditions with a synthetic gel type catalyst consisting of a major proportion of silica, a minor proportion of alumina and about 0.5 percent of Fe_2O_3. Simultaneous cracking and desulfurization is effected.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,458,870. Hydrogenation of an Oxide of Carbon. H. J. Ogorzaly to Standard Oil Development Company.

In the production of hydrocarbons and oxygenated hydrocarbons from CO and H_2 in the presence of a powdered iron catalyst, the catalyst is maintained in the reactants in the form of a dense fluidized mass. Contaminated catalyst is conveyed into a separate hydrogenation zone where a dense fluidized mass of this catalyst is formed in an H_2-containing gas and the catalyst is maintained at a temperature of at least 900° F. for a sufficient period of time to remove at least 80 percent of the contaminants. The pressure in this zone can be the same as that maintained in the reaction zone.

U.S.P. 2,458,960. Apparatus for Reactions Requiring Short Contact Time. B. E. Roetheli and W. G. Scharmann to Standard Oil Development Company.

The apparatus according to this patent makes it possible to control the time of a chemical reaction, e.g. the catalytic dehydrogenation of hydrocarbons, accurately within narrow limits by quenching the reaction mass with a cooler solid material. Catalyst cooler than the reaction mixture can be employed as the quenching means.

U.S.P. 2,458,980. Production of Gasoline. R. M. Cole to Shell Development Company.

A thermal gasoline stock with an ASTM octane number N is hydrogenated under conditions to effect such a percentage saturation of the stock S that $S = 11 + 4.7 (N' - N) \mp 5$ wherein N' is the desired improved ATSM octane number of the hydrogenated product leaded by addition of tetraethyl-lead. The hydrogenation can be carried out at a temperature of 400-850° F., and the saturation can be controlled by varying the space velocity.

U.S.P. 2,459,444 Hydrocarbon Synthesis. T. C. Main to Standard Oil Development Company.

In the hydrocarbon synthesis from CO and H_2 by means of a fluidized iron catalyst, a solid diluent of lower density and larger average particle size than this catalyst is admixed with it to maintain it in a fluidizable state for an extended period of time. The relative densities and particle sizes of both these components shall be such that their separation is avoided. Powdered silica gel or sand can be employed as the diluent.

U.S.P. 2,459,449. Catalytic Dehydrogenation of Olefinic Hydrocarbons While Maintaining the Potassium Content of the Catalyst. E. H. Oliver and C. F. VanBerg to Standard Oil Development Company.

Normal mono-olefin with more than three C atoms is converted into the corresponding diolefin in the presence of a catalyst which consists of a major amount of MgO, a small amount of iron oxide, and a small amount of K_2O. A mixture of the mono-olefin and steam is passed at reaction temperature through a catalyst bed which contains in a thin first layer a relatively large amount of K_2O and in a thick second layer a relatively small amount of K_2O.

U.S.P. 2,459,465. Two-Stage Hydrogenation Treatment for Hydrocarbon Oils. W. M. Smith to Standard Oil Development Company.

The details of a two-stage hydrogenation process of a gas oil containing aromatics, sulfur and nitrogen are given. A sulfactive catalyst consisting of the sulfide of a metal of groups VI and VIII of the periodic system is employed in the first hydrogenation stage and the nitrogen and sulfur compouds of the feed stock are converted to volatile compounds in this stage. The resulting product freed from these compounds is contacted in a second zone with hydrogen and a sulfur-sensitive catalyst.

U.S.P. 2,459,907. Method of Conducting Chemical Reactions. N. M. Winslow and G. W. Heise to National Carbon Company, Inc.

In a method of conducting a reaction between fluid reactants, preferably a liquid and a gaseous reactant, e.g. in the addition of HCl to an olefin, hydrogenation and dehydrogenation, the reactants are concurrently passed through a unitary mass of porous carbon bonded by carbon to and filling the cross-section of an impervious tube. This mass, which can be impregnated with catalytic material, replaces the columns of granular materials otherwise employed.

U.S.P. 2,460,508. Method and Means for Hydrocarbon Synthesis. E. A. Johnson and S. B. Backer to Standard Oil Company (Indiana.)

One portion of a mixed stream of CO and H_2 gases is reacted over a cobalt synthesis catalyst, while another portion of this stream is reacted over an iron synthesis catalyst. Residual gas from the cobalt catalyst zone is supplied to the iron catalyst zone. At least a portion of the hydrogen-rich gas recovered from the iron catalyst zone is supplied after separation of CO_2 to the cobalt catalyst zone. Increased outputs in hydrocarbons and other conversion products are obtained by this combined process.

U.S.P. 2,461,064-5. Method of Manufacturing Motor Fuel. L. C. Kemp, Jr. to The Texas Company.

The reaction products of a hydrocarbon synthesis from CO and H_2 are separated into a liquid and a gaseous fraction. The liquid fraction is continuously contacted with finely divided, solid hydrocarbon-conversion catalyst at cracking temperature. At least a portion of the gaseous effluent of the synthesis operation is utilized for stripping the spent conversion catalyst. At least a portion of the CO_2 produced in the regeneration of this catalyst is added to the synthesis gas together with a second portion of said gaseous effluent. Further details of the process for preparing high-octane gasoline are also claimed in both patents.

U.S.P. 2,461,147. Dehydrogenation Process. E. P. Davies and F. T. Eggertsen to Shell Development Company.

Vapors of a hydrocarbon, such as butylene, are dehydrogenated at a temperature above 580°C. with added steam in the presence of steam-stable pellets

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of an alkali-promoted iron oxide catalyst having an apparent density below 0.520 of the absolute density and an available surface of less than about 10 square meters per gram. High yields of the corresponding dehydrogenated hydrocarbons, such as butadiene, are obtained.

U.S.P. 2,461,153. Method of Manufacturing High Antiknock Synthesis Gasoline. A. R. Goldsby to Texaco Development Corporation.

From the mixed gaseous and liquid paraffin and olefin hydrocarbon products obtained in a Fischer-Tropsch synthesis process a light naphtha fraction is separated which contains liquid olefins and paraffins from C_5 to C_7 or C_8 and also a heavy naphtha fraction above C_7. Olefins are absorbed from the light naphtha fraction by contacting it with an acid alkylation catalyst. A low-boiling isoparaffin is alkylated with the absorbed olefins in the presence of an alkylation catalyst to obtain a product within the gasoline boiling range. The heavy naphth fraction is catalytically converted at a temperature of 900-1100°F. to produce a broad boiling range gasoline of improved antiknock value. A gasoline fraction obtained therefrom is combined with the gasoline alkylate.

U.S.P. 2,461,331. Process for Dehydrogenation of Hydrocarbons in the presence of a Gaseous Diluent. C. J. G. Leesemann to Standard Oil Development Company.

Streams of hydrocarbons and a diluent are preheated to active dehydrogenation temperature. The diluent stream, which is in excess of the hydrocarbon stream, is then charged to the inlet of a zone containing a bed of dehydrogenation catalyst while the hydrocarbon stream is charged into this zone at a plurality of points between its inlet and outlet. A progressively decreasing ratio of diluent to hydrocarbons is maintained as the mixture formed passes through the catalyst zone. Steam can be employed as the diluent.

REFINING

U.S.P. 2,458,494. Stabilization of Vinyl Compounds. J. R. Durland to Monsanto Chemical Company.

Polymerization of monomeric styrene is inhibited by an addition of x/di-(p. tert. butyl meta cresol) monosulfide or a monosulfide of monobutylated meta cresol.

U.S.P. 2,458,535. Modified Hydrocarbon Compositions and Petroleum Distillates. S. Shappirio.

A petroleum distillate boiling above kerosine is incorporated with a hydrogenated bacterial extract in an amount sufficient to exhibit antioxygenic properties for the distillate.

U.S.P. 2,458,777. Purification of Hydrocarbons. H. I. Hepp and H. R. Sailors to Phillips Petroleum Company.

A hydrocarbon stock containing benzene, toulene, or xylenes, and olefinic impurities is contacted in a first zone with an $AlCl_3$-hydrocarbon complex and in a second zone with the same complex in the presence of anhydrous HCl. Further details of the process for removing the olefinic impurities in a continuous countercurrent process are claimed.

U.S.P. 2,459,403. Segregation of C_5 Hydrocarbons by Extractive and Azeotropic Distillation. G. L. Ahrens to Standard Oil Development Company.

Isoprene, transpiperylene, and cyclopentene are separated from a mixture with non-cyclic mono-olefins in a cracked C_5 hydrocarbon fraction. One volume part of this fraction is distilled in the presence of 2-3 volume parts of an aqueous acetone solvent which increases the relative volatilities of non-cyclic mono-olefins and leaves a residual portion of the solvent containing the diolefins and the cyclopentene. An azeotropic mixture of isoprene and solvent with a portion of the cyclopentene is distilled from the residual solvent. The residue left, which contains transpiperylene and another portion of the cyclopentene, is redistilled in the presence of an added amount of the same solvent to separate the distilling transpiperylene and solvent from cyclopentene dissolved in excess solvent.

U.S.P. 2,459,404. Method and Apparatus for Controlling Multicomponent Separation Process in Accordance with Light Absorption Characteristics. J. A. Anderson, Jr. to Standard Oil Development Company.

In a multistage distillation process a feed stream is separated by distillation to obtain from at least two successive stages at least three product streams, each of which has an unique absorption characteristic for different wave lengths of light. At least the intermediate stream is continuously analyzed to obtain from this analysis at least two electrical potentials, the first of which is a function of a unique light absorption characteristic at a predetermined wave length of light for the predominant component in the first or low boiling product stream, and the second of which potentials is a function of a corresponding characteristic at a different wave length for the predominant component in the third or high boiling product stream. The first potential is employed to control the first of the two successive stages and the second potential to control the second stage in the process of separating the feed stream into the product streams.

U.S.P. 2,459,419. Method of Refining Hydrocarbon Oil. B. K. Engel and F. T. E. Palmquist to Aktiebolaget Separator—Nobel.

Mineral oils to be refined are treated in a first step with concentrated H_2SO_4 for a short period at a low temperature so that only the more unstable components of the oil are dissolved and water yielding reactions are inhibited. The resulting mixture is centrifuged to separate two phases, one of which is pre-refined oil. This product is further refined in a plurality of steps similar to the first.

U.S.P. 2,459,434. Distillation of Hydrocarbons to Remove Fluorine Compounds. E. R. Kanhofer to Universal Oil Products Company.

The reaction effluent of a hydrocarbon conversion process in the presence of a HF-catalyst, e.g. of an alkylation process, is freed from fluorine compounds by fractionally distilling the mixture to separate HF from unconverted reactants and higher boiling reaction product. The unconverted reactants are then separated from this product by further fractionation. At least a portion of this product is recycled to the first distillation step.

U.S.P. 2,459,410. Azeotropic Distillation of 2, 3-Dimethybutadiene from Methyl Pentadiene. R. C. Brandon to Standard Oil Development Company.

2,3-dimethylbutadiene is separated from its mixture with methyl pentadiene by distilling the mixture with methanol. The dimethylbutadiene distills as an azeotrope with the methanol.

U.S.P. 2,459,442. Separation of Hydrocarbons. M. R. Lipkin to Sun Oil Company.

Unsaturated non-aromatic hydrocarbons are separated from their mixture with saturated hydrocarbons by treating the liquid mixture with silica gel to preferentially adsorb the unsaturates. The enriched adsorbent is desorbed at ordinary temperature with a saturated hydrocarbon liquid other than that remaining after adsorption of the unsaturates from the mixture. The desorbed adsorbent is directly re-used while still wet.

U.S.P. 2,459,451. Butadiene Extraction. J. W. Packie and E. M. Glazier to Standard Oil Development Company.

The details of a process for the liquid phase solvent extraction of an olefin from a mixture of olefins and saturated hydrocarbons in a plurality of stages are claimed. Each stage comprises a turbine-type agitator and a settling chamber.

U.S.P. 2,459,454. Concentration of Piperylene. R. F. Robey to Standard Oil Development Company.

Piperylene is continuously recovered from a mixture of C_5 hydrocarbons by reacting it with liquid SO_2 after having treated the mixture with an anti-oxidant. Formation of piperylene monosulfone is effected in two stages. In the first stage the mixture is contacted with an excess of a liquid SO_2 phase containing dissolved piperylene monosulfone formed in the second stage. The reaction products of the first stage are separated into a piperylene monosulfone phase and an unreacted hydrocarbon phase. The latter is contacted in the second stage with an excess of anti-oxidant treated liquid SO_2 at 100°C. The liquid SO_2 phase containing dissolved piperylene monosulfone separated from the reaction products of this second stage is passed to the first stage. The piperylene monosulfone from the first stage is decomposed to recover piperylene.

U.S.P. 2,460,019. Method and Apparatus for Countercurrent Contacting of Liquids. J. D. Long and C. O. Rhys, Jr. to Standard Oil Development Company.

The invention relates to the countercurrent contacting of immiscible liquids of different gravities, e.g. in refining operations, such as in the treatment with water of a hydrocarbon stream from an extractive distillation to remove water-soluble solvent. Details of the process and apparatus are claimed.

U.S.P. 2,460,056. Purification of Unsaturated Hydrocarbon Mixtures. H

L. Yowell and M. W. Swaney to Standard Oil Development Company.

Hydrocarbons contaminated by aldehydes, for example in the production of unsaturated hydrocarbons from more saturated ones by cracking in the presence of small amounts of air, steam, or the like, are contacted with a dilute aqueous solution of ammonia or a water-soluble amine to bind and remove the contaminants from the hydrocarbons.

U.S.P. 2,461,346. Separation of Hydrocarbons. J. A. Patterson to Standard Oil Development Company.

The constituents of a closely boiling mixture containing C_5 paraffins and monoolefins, isoprene and cyclopentadiene are separated from one another by fractional distillation in the presence of acetone as a solvent. The paraffins and monoolefins are removed as distillate in an extractive distillation zone, isoprene and cyclopentadiene are removed as an intermediate fraction containing solvent, and the remaining solvent together with dicyclopentadiene formed in the operation is removed as bottoms. Details for further separation of the single constituents from the fractions thus formed by redistillation, stripping and extracting operations are claimed.

DESULFURIZATION

U.S.P. 2,460,227. Extraction of Elemental Sulfur from Oils. J. A. Hart, L. N. Hollis and J. W. Randolph to Socony-Vacuum Oil Company, Inc.

Gasoline is freed from elemental sulfur by contacting the gasoline with an aqueous solution containing 1-35 percent alkali metal hydroxide, 5-10 percent Na_2S, and 0.5-10 percent aromatic mercaptans, e.g. thiocresols. The elemental sulfur is dissolved in this aqueous solution and separated with it from the gasoline.

ALKYLATION

U.S.P. 2,459,636. Alkylation Method and Apparatus. W. N. Fenney to The Texas Company.

In the alkylation of hydrocarbons with an olefin or similar alkylating agent, this agent is dispersed in liquid phase through a small jet into a mix of the hydrocarbon and catalyst while moving the jet through the reaction zone in a cylindrical path at high linear velocity. The jet stream is subjected throughout its path to violent impact immediately after its dispersion into the reaction zone.

U.S.P. 2,459,775. Process of Alkylation in the Presence of a Double Fluoride Catalyst. H. J. Passino to The M. W. Kellogg Company.

Isoparaffin and aromatic hydrocarbons are alkylated by olefins in the presence of a catalytic material which comprises a compound of HF and a fluoride of an alkali metal, alkaline earth metal or ammonium.

U.S.P. 2,460,719. Process of Alkylation in the Presence of Water as Catalyst. W. A. Stover to Socony-Vacuum Oil Company, Inc.

An excess of alkylatable paraffinic hydrocarbons is contacted with olefin of at least 3 C atoms in gaseous phase at a temperature of 700-850° F. and a pres-

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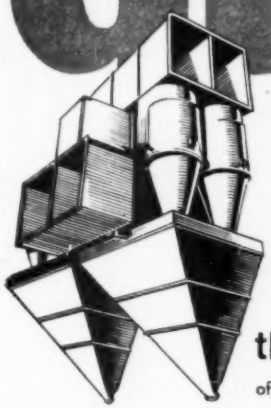

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POLYMERIZATION AND CONVERSION

U.S.P. 2,458,498. Method and Apparatus for Conversion of Fluid Hydrocarbons. E. V. Bergstrom to Socony-Vacuum Oil Company, Inc.

Fluid hydrocarbons to be converted to lower boiling hydrocarbons are passed downwardly under conversion conditions within a compact column of downwardly flowing particle-form contact material. Gaseous products are collected in a plurality of spaces within the lower section of the column. The contact material is passed around these spaces to a settling space and from there to a compact bed of contact material. The gaseous products from each of the collecting spaces are passed as a confined stream to the settling space and are then withdrawn.

U.S.P. 2,458,499. Method and Apparatus for Conversion of Fluid Hydrocarbons. E. V. Bergstrom to Socony-Vacuum Oil Company, Inc.

The method claimed has some resemblance to that described in U.S.P. 2,458,498. The contact material flows from the lower section of the conversion zone as a plurality of spaced downwardly extending streams onto an equal plurality of limited accumulations of downwardly flowing material maintained in the upper portion of a second confined zone. The accumulations serve to throttle the flow of contact material from said streams. Further details of the method are also claimed.

U.S.P. to 2,458,818. Solid Catalyst Treatment of Gaseous Hydrocarbons. D. W. Young to Standard Oil Development Company.

Normally gaseous olefins are contacted at a temperature of 100-300° C. with a silica gel catalyst containing titanium oxide dispersed in the gel by hydrolizing $Ti(SO_4)_2$ in a $KHCO_3$ solution mixed with silica hydrogel followed by calcination at a temperature of 1470-1670° C. of the gel formed. Hydrocarbons boiling in the gasoline boiling range are obtained by this polymerizing treatment.

U.S.P. 2,458,862. Preventing Secondary Reactions in Catalytic Processes. R. W. Krebs to Standard Oil Development Company.

The patent describes a method to prevent undesirable secondary reactions in the treatment of a gas flowing upwardly through a reaction zone which contains a layer of finely divided catalyst in dense, turbulent condition, into a space which contains a relatively small amount of catalyst. An inert quenching gas is injected into this space. The temperature of the reaction gases passing through the space is reduced below that which causes secondary reactions. The method can also be used in the regeneration of catalysts contaminated by combustible deposits.

U.S.P. 2,458,866. Removing Entrained Gaseous Fluids from Solids. H. Z. Martin to Standard Oil Development Company.

An apparatus is described and claimed which permits stripping or purging volatile entrained material from solid particles, for example hydrocarbons from contaminated catalyst particles.

U.S.P. 2,458,977. Hydrocarbon Conversion Process. D. R. Carmody to Socony-Vacuum Oil Company, Inc.

An olefin is mixed with a solution of metallic halide catalyst under such reaction conditions that a high viscosity polymer product is produced. A different type olefin from that originally employed is then admixed with the reaction mixture containing the dissolved catalyst under such conditions as to produce a polymer product of a viscosity sufficiently less than that of the first product that separation of the two polymer products is permitted. The catalyst complex is removed from the reaction mixture and admixed with an olefin under such conditions as to obtain a polymer of a viscosity similar to that of the product of the second step. After combining the reaction mixture of the second step with that of the third step, polymers of high and of low viscosity are recovered as separate fractions.

U.S.P. 2,459,096. Method and Apparatus for Fluid Hydrocarbon Conversion. F. E. Ray to Socony-Vacuum Oil Company, Inc.

In the conversion of fluid hydrocarbons to lower boiling gaseous hydrocarbons in the presence of particle-form contact material moving as a compact column in the same downward direction as the hydrocarbons, the flow of contact material in the lower section of the column is baffled at a plurality of vertically spaced locations to provide vertically separated gas collecting spaces of equal width which are shielded from gravity flow of contact materials. Details for the arrangement of these gas spaces and their vertical distances from one another are claimed.

U.S.P. 2,459,109. Direct Synthesis of Alkyl Substituted Styrene Polymers. A. F. McKay to Dominion Tar Chemical Company, Ltd.

Acetylene is reacted with an alkylated benzene having not more than three alkyl groups in the presence of a stable aliphatic ether-boron trifluoride complex saturated with BF_3. A mercury salt can be added to this catalyst. Alkyl substituted styrene polymers are directly obtained. Temperature of —30° to +70° C. are particularly useful.

U.S.P. 2,459,824. Method and Apparatus for Contacting Subdivided Solid Contact Material with Fluid Reactants, Particularly Hydrocarbons. F. W. Leffer to Universal Oil Products Company.

In the conversion of hydrocarbons passed through a downwardly moving bed of solid catalyst particles, with continuous regeneration of these particles by regenerating gas passing upwardly through the contaminated catalyst particles in a zone disposed vertically below the conversion zone, the regenerated catalyst particles are suspended in a hydrocarbon stream comprising a portion of the conversion products and flowed upwardly with it in a confined straight line path which extends through the catalyst beds in both zones. The suspension is then discharged into the reaction zone, and the conversion products are removed therefrom.

U.S.P. 2,459,836. Controlling Reaction Temperatures. E. V. Murphree to Standard Oil Development Company.

The reaction temperature in hydrocarbon conversion and other chemical processes is controlled by carrying out the reaction in indirect heat exchange relationship with a large body of finely divided solid material and passing a gas upwardly through these solids at an adjusted velocity to obtain a fluidized layer of solids superposed by a dispersed phase. Details of this method are claimed.

U.S.P. 2,460,038. Emulsion Polymerization Process. G. E. Serniuk to Standard Oil Development Company.

In the polymerization of butadiene-1,3, alone or in mixture with other unsaturated compounds, in an aqueous emulsion containing a water-soluble soap-emulsifier, small amounts of a hydrocarbon soluble peroxide, an alkali persulfate catalyst, a mercapto polymerization modifier and an unsaturated free higher fatty acid are added. The physical characteristics of the resulting synthetic rubber are improved by the free fatty acid additive.

U.S.P. 2,460,151. Apparatus for Gas-Solid Contact Operations. E. L. Sinclair to Socony-Vacuum Oil Company, Inc.

The apparatus described can, for example, be used in such gas-solid contact operations as catalytic cracking, hydrogenation, isomerization, alkylation, etc., of hydrocarbons. It has a plurality of superimposed rows of horizontally extending, inverted, spaced through members arranged in a particular manner with respect to one another and to their respective openings. The apparatus makes possible the passing of a large volume of contact gas uniformly through substantially all portions of a confined column of solid particles without causing disruption of this column.

U.S.P. 2,460,219. High-Temperature Hydrocarbon Conversion Process. S. C. Eastwood to Socony-Vacuum Oil Company, Inc.

Details are claimed of a continuous process for conducting endothermic conversions of fluid hydrocarbons at elevated temperature in the presence of a moving particle form solid contact material. It is possible by this process to conduct such endothermic conversions at temperatures which are at least partially above those at which it has been heretofore found practical to convey solid particles.

U.S.P. 2,460,567. Aromatic Mercapto-Aliphatic Ethers as Modifiers for Butadiene Emulsion Polymerization. G. L. Browning, Jr., to The B. F. Goodrich Company.

Butadiene-1,3, or a mixture thereof with styrene, is polymerized in aqueous emulsion in the presence of an aromatic mercapto-aliphatic ether wherein an ether linkage is attached on the one hand to a carbon atom of an aliphatic mercapto group and on the other hand to a nuclear carbon atom of an aromatic group with 6 to 24 C atoms. Beta-(p-alkyl phenoxy)-beta'-mercapto-

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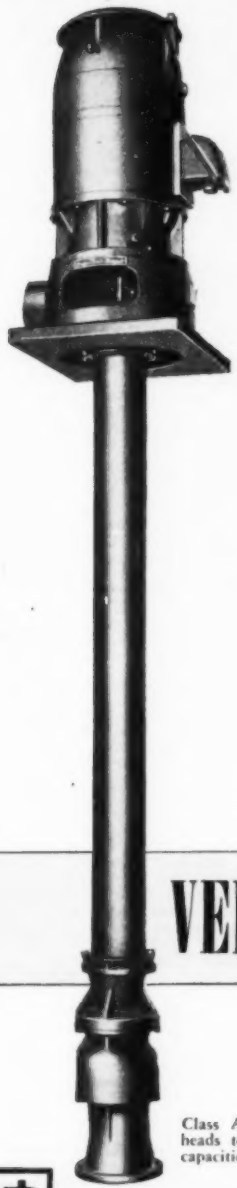

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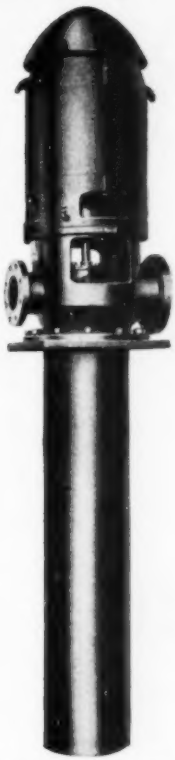

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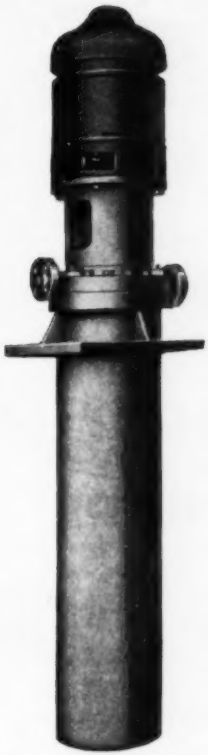

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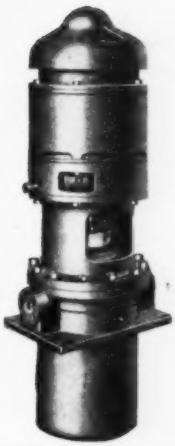

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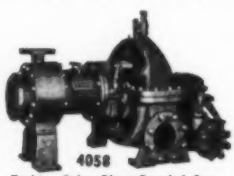

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diethyl ether is an example of the additive. Synthetic rubbers of improved milling properties and of lower hysteresis and higher flex-cracking resistance on vulcanization are obtained.

U.S.P. 2,460,300. Polymeric Products Derived from Diolefins and Vinyl Aromatic Compounds and Method of Making Same. W. J. LeFevre and K. G. Harding to The Dow Chemical Company.

Conjugated aliphatic diolefins, such as butadiene-1,3, and monovinyl aromatic compounds, such as styrene, are alternately emulsified with water and polymerized, the emulsification and polymerization of the second material being carried out after addition to the first polymerization reaction product within its aqueous colloidal solution. These alternating steps can be repeated under addition of catalysts.

U.S.P. 2,460,606. Creatine and Creatinine as Catalysts for Polymerization of Butadiene. W. D. Stewart to The B. F. Goodrich Company.

An aqueous soap emulsion of butadiene-1,3 with or without addition of styrene or acrylonitrile is polymerized in the presence of a catalytic amount of creatine or creatinine. The time required for polymerization is reduced by use of these compounds.

U.S.P. 2,460,973. Low-Temperature, Hydrogen Fluoride Catalyzed Polymerization of Conjugated Diolefins. J. D. Calfee and J. H. Pearson to Allied Chemical and Dye Corporation.

A conjugated aliphatic diolefin is polymerized at a temperature below 0° C. by means of anhydrous HF-catalyst in the presence of an inert halogenated aliphatic hydrocarbon solvent for both the diolefin and the HF, such as ethylidene fluoride.

U.S.P. 2,460,976. Method of Making Plastic Polystyrene. J. W. Church to Falk and Company.

Monomeric styrene is heated in aqueous emulsion with a protective colloid formed by casein or glycinin. The thermal polymerization is continued until a solid spongelike product of macromolecular structure comprising high polystyrenes and the protective colloid forms and separates from the reaction liquid. A fine aqueous suspension of the separated reaction product is formed and then recovered from this suspension in a plastic mass by admixture of a non-evaporative solvent plasticizer. A very tough elastic mass is produced which is capable of forming a self-supporting film.

U.S.P. 2,461,104. Method of Catalysis. J. R. Bates to Sun Oil Company.

In catalytic operations in which fluids are contacted with a solid particle catalytic mass continuously circulating through, out of and back to the treating zone, the powdered fines formed by mechanical attrition of the catalyst and entrained by the fluids leaving this zone are separated after removal from these fluids into a fraction larger than 150 mesh and one finer than 150 mesh. A small percentage of these remaining fines is returned to the circulating catalyst to lubricate the mass and thereby minimize attrition.

U.S.P. 2,461,172. Pyrolytic Conversion of Hydrocarbons. H. L. Pelzer to Sinclair Refining Company.

A suspension of a finely divided solid conversion catalyst is injected as a vertical, high velocity stream into the lower end of a conversion chamber containing hydrocarbon vapors to be converted. The velocity of the stream is suddenly broken and it is deflected downwardly and radially outwardly so that the turbulence of the radially directed stream is reduced and it is uniformly distributed. The suspension is then passed upwardly through the conversion chamber. Higher yields of valuable conversion products are effected by the uniform distribution of the suspended catalyst in the oil vapors.

ISOMERIZATION

U.S.P. 2,460,303. Gasoline Manufacture. S. H. McAllister, J. Anderson and W. H. Peterson to Shell Development Company.

Ethylene or a mixture of ethylene and propylene, as obtained for example by cracking propane, is contacted with reduced cobalt deposited on activated carbon or a similar carrier at a temperature of 30-150° C., preferably under a pressure of above 300 psi. The resulting normal alpha olefins of four to five C atoms are isomerized to the corresponding beta olefins which are reacted with an isoparaffin under alkylating conditions. High anti-knock value saturated liquid hydrocarbons for motor fuel are obtained.

U.S.P. 2,460,852. Isomerization of Cycloparaffins of Nonhydroaromatic Structure. R. N. Shiras, A. C. Nixon and C. H. Deal to Shell Development Company.

Cycloparaffins of hydroaromatic structure, such as cyclohexane, free of substantial amounts of aromatic hydrocarbons are obtained from a hydrocarbon fraction (e.g., a naphthenic gasoline fraction) comprising cycloparaffins of hydroaromatic and nonhydoraromatic structure in admixture with close boiling open chain paraffin and aromatic hydrocarbons by a combined method of distillation, fractionation and isomerization, the details of which are claimed.

PETROCHEMICALS

U.S.P. 2,458,512. Acylation of Thiophene. H. D. Hartough and A. I. Kosak to Socony-Vacuum Oil Company, Inc.

A thiophene is reacted with an acyl halide or an anhydride of a carboxylic acid in the presence of a porous, absorptive catalyst comprising silica and at least one oxide of a metal of group IV, sub-group A or of the iron sub-group of group VIII of the periodic table, e.g. a silica-thoria or silica-zirconia composite. Nuclear acylation of the thiophene is effected, such compounds as acetyl thiophene or benzoylthiophene, for example, being formed.

U.S.P. 2,458,266. Process for Making Ethylene Oxide. R. L. Heider and C. J. Stehman to Monsanto Chemical Company.

Ethylene and oxygen-containing gases are passed at temperatures of 225-350° C. over a silver catalyst supported on a mixture of crystalline alpha-silica and alpha-alumina, the alumina comprising 2-15 percent by weight of this carrier. This carrier makes it possible

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U.S.P. 2,457,882. Hydration of Olefins. F. E. Frey to Phillips Petroleum Company.

An aliphatic olefin is treated with an aqueous solution of HF and a NiF_2, AlF_3, CaF_2, SrF_2, BF_3, or the like promoter in well-defined proportions at a temperature of 75-300° C. for a reaction period of 5-15 minutes and at a superatmospheric pressure sufficient to maintain the aqueous solution in the liquid phase. The aliphatic alcohol corresponding to the olefin employed is recovered.

U.S.P. 2,458,513. Process for the Acylation of Thiophene. H. D. Hartough and A. I. Kosak to Socony-Vacuum Oil Company, Inc.

The process according to this patent differs from that of U.S.P. 2,458,512 substantially in that the catalyst is formed by a porous, absorptive material impregnated with a strong hydroxy acid having an initial ionization constant greater than 1.0×10^{-4} and containing at least one of the elements S, P and F. Orthophosphoric acid, sulfuric acid and dihydroxy fluoboric acid are examples of the impregnating acids.

U.S.P. 2,458,514. Continuous Catalytic Process for the Acylation of Thiophenes. J. Kellett, III and H. E. Rasmussen to Socony-Vacuum Oil Company, Inc.

The process according to this patent is closely related to that of U.S.P. 2,458,513. Orthophosphoric acid without a porous carrier is employed here as the catalyst in a continuous process.

U.S.P. 2,458,519. Acylating Thiophene with Silica-Alumina Catalyst. A. I. Kosak and H. D. Hartough to Socony-Vacuum Oil Company, Inc.

The process according to this patent differs from that of U.S.P. 2,458,512 in that a silica-alumina catalyst, e.g. a porous absorptive clay, is employed.

U.S.P. 2,458,520. Acylation of Thiophene. A. I. Kosak and H. D. Hartough to Socony-Vacuum Oil Company, Inc.

The process according to this patent differs from that of U.S.P. 2,458,513 only in that the strong hydroxy acids there named are employed here as the catalysts without use of the porous carrier.

U.S.P. 2,458,521. Acylating Thiophene with Silica-Hydrous Metallic Oxide Catalyst. A. I. Kosak and H. D. Hartough to Socony-Vacuum Oil Company, Inc.

A mixture of a thiophene and an acyl halide or an anhydride of a carboxylic acid is passed through a bed of porous, absorptive silica-hydrous metallic oxide catalyst maintained at a temperature sufficient to vaporize the mixture. Acylated thiophene is recovered from the condensed vapors ensuing from the catalyst bed.

U.S.P. 2,458,603. Preparation of Ketones by Catalytic Reaction of Olefins and Acid Anhydrides. C. E. Johnson to Standard Oil Company (Indiana.)

An olefin is intimately mixed with a carboxylic acid anhydride in the presence of an alkane sulfonic acid catalyst, e.g. ethanesulfonic acid. The resulting ketone is recovered from the mixture. High mol. wt. ketones can be prepared by this method by use of polymers of propylene, butylene, or the like, as the olefins.

U.S.P. 2,458,691. Apparatus for Chlorination Processes. J. Dorsky, G. W. Mattson and C. M. Neher to Ethyl Corporation.

A photochemical apparatus for the chlorination of hydrocarbons is claimed. The straight glass reactor is transmissive to actinic light and is surrounded by a jacket for a heat removing liquid. The chlorine is fed through a coaxial tube with a multiplicity of jets projecting axially and circumferentially apart into the reactor chamber.

U.S.P. 2,459,049. Photochemical Chlorination of Hydrocarbons. J. S. Sconce and A. N. Johnson to Hooker Electrochemical Company.

In the photochemical chlorination of paraffinic hydrocarbons with 3-7 C atoms a mixture of the paraffins with chlorine is first formed in which the proportion of hydrocarbon is above or below the explosive range. After causing reaction the deficient reagent is added by proportioned increments until the desired end point is reached. The mixtures are deactivated after each reaction and before addition of the next increment.

U.S.P. 2,459,126. Copolymers of Vinyl Compounds Containing Olefins. A. M. Clifford to Wingfoot Corporation.

A cracked-petroleum fraction with high contents in butadiene and monoolefins of 3-5 C atoms is polymerized in aqueous emulsion with an acrylonitrile. A rubber-like material is formed.

U.S.P. 2,459,423. Reaction of Organic Compounds with Hydrogen Halides. A. T. Gebhart to Colgate-Palmolive-Peet Company.

Unsaturated organic compounds, such as styrene, are mixed with a solution of anhydrous HBr or HCl in liquid SO_2. The resulting halogenated product is separated from the SO_2.

U.S.P. 2,459,501. Polymeric Mono-Isoolefinic Materials and Process of Making Same. J. M. Coon and J. B. Rust.

A mixture of a mono-isoolefin (e.g. isobutylene) and an unsaturated aliphatic alcohol ester of an alpha beta dicarboxylic acid in the ratio of 10:1 to 10:5 by weight is treated while liquid with a Friedel-Crafts catalyst at a temperature below—40°C. The alcohol of said ester can be allyl, methallyl, crotyl, butenyl, propargyl, or butinyl alcohol. For example an allyl ester of the acid $COOH\,CH=CH\,COOH$ can be employed. A soft, elastic and rubbery product is obtained.

U.S.P. 2,459,690. Oxidation of Cycloaliphatic Hydrocarbons and Alcohols. T. F. Doumani, C. S. Coe and E. C. Attané, Jr. to Union Oil Company of California.

Aqueous HNO_3 is continuously introduced into a vertical column of a liquid cycloaliphatic hydrocarbon, e.g. cyclohexane, maintained at elevated temperature. While the hydrocarbon is introduced near the top of the column, the HNO_3 is introduced at a point near its center. The portion of hydrocarbon above this point is contacted with gaseous decomposition products of HNO_3. The nitration product thus formed, comprising nitrocycloparaffin and unreacted cycloparaffin, is contacted in the lower part of the column with aqueous HNO_3 under formation of dibasic acids.

U.S.P. 2,460,705. Chlorinolysis. E. T. McBee and O. R. Pierce to Purdue Research Foundation.

Aromatic hydrocarbons which contain one or more isopropyl groups are chlorinated by an amount of chlorine in excess of that theoretically required to perchlorinate all of the alkyl substituents, in the presence of actinic light at a temperature of 20-200°C. for a period of time sufficient to cause chlorinolysis of the isopropyl substituent to a pentachloroethyl group and to perchlorinate any other alkyl groups. 1-pentachloroethyl-4-(trichloromethyl)-benzene is thus obtained from p-cymene.

U.S.P. 2,461,010. Process for the Recovery of Ammonia. J. W. Teter and R. H. Stookey to Sinclair Refining Company.

In the amination of propylene by ammonia at elevated temperature and pressure in the presence of a catalyst for selectivity aminating the propylene, the resulting reaction mixture is stabilized to recover the aminated propylene and to produce a gaseous mixture of the unreacted components ammonia, propane and propylene. The gaseous mixture is cooled to a temperature of 0°F. under sufficient pressure to establish liquid phase conditions. The two layers formed on settling, one of which comprises the ammonia and the other the propane and propylene, are separated from one another.

U.S.P. 2,461,142. Production of Beta-Trichlorethane. O. W. Cass to E. I. duPont de Nemours and Company.

Chlorine, HCl and acetylene are passed in equimolecular proportions into a liquid chlorohydrocarbon containing a predominant amount of beta-trichlorethane at a temperature of —30°+25°C. in the presence of actinic light. Beta-trichlorethane is produced. The danger of explosions is eliminated by this process.

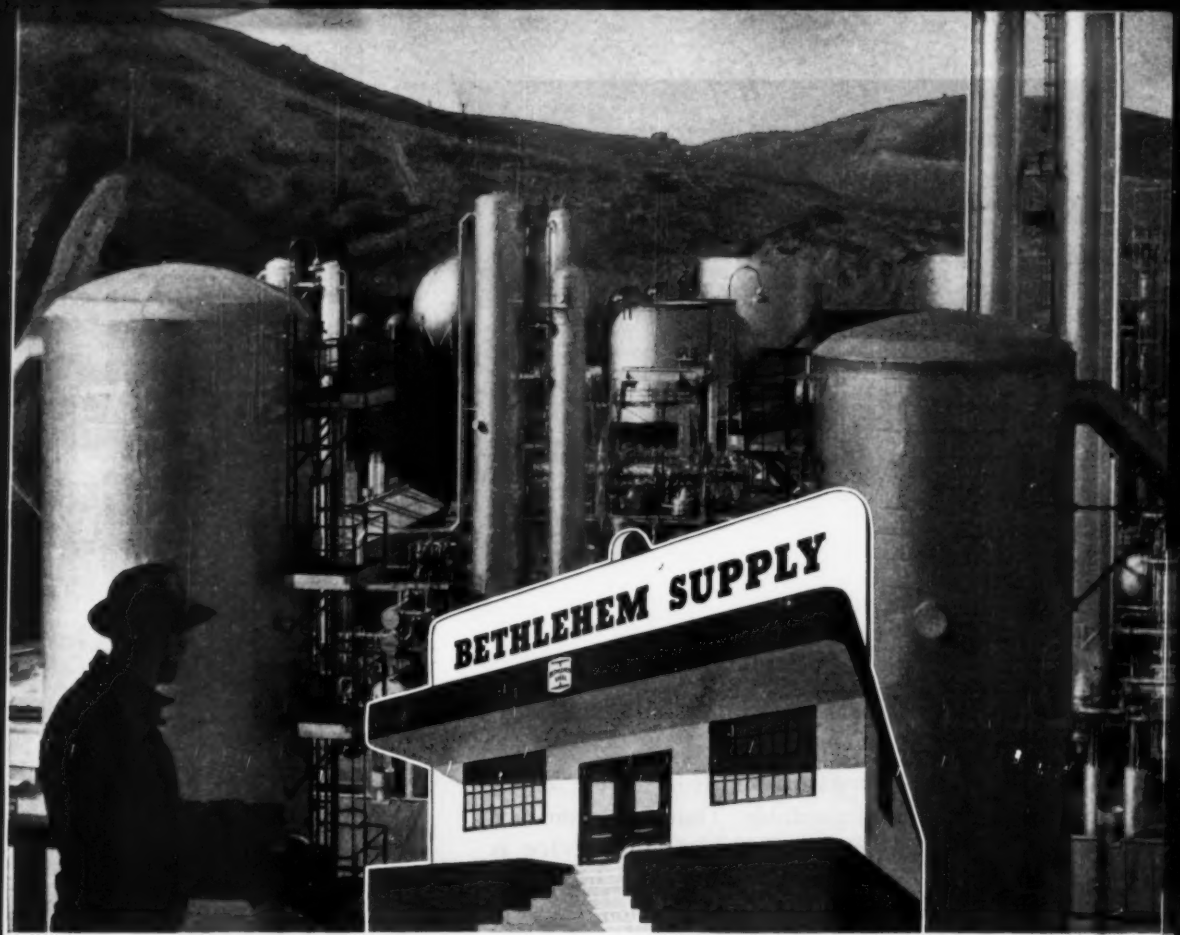
U.S.P. 2,461,358. Diolefin Polymerization in the Presence of Ammonium Soap Emulsifier. B. M. Vanderbilt and F. Bascom to Standard Oil Development Company.

A mixture of butadiene-1,3 and an acrylic nitrile is polymerized in an aqueous emulsion containing as the emulsifier a mixture of a soap-forming fatty acid and 5-75 percent molar excess of ammonia over that required to react with the fatty acid. Rubber-like materials are obtained.

HEAVY OILS AND WAXES

U.S.P. 2,459,112-6. Mineral Oil Composition. E. A. Oberright to Socony-Vacuum Oil Company, Inc.

The characteristics of mineral oil are improved by additives obtained by reaction of one mol of an aldehyde, one mol of a hydroxy aromatic compound and at least ¼ mol of a polyamine in which each amino group has at least one hydrogen atom. According to U.S.P. 2,459,112 this reaction is carried out at a temperature of 25-110°C. and depres-



Your neighbor in refinery centers

That's one big advantage of having *many* stores—there's one near everybody in leading refinery centers of the Midcontinent, Gulf Coast, and Rocky Mountain areas. Here Bethlehem's yellow-and-black store fronts are familiar signals of big stocks, quick service, and friendly treatment.

Whenever you want refinery supplies—furnaces, valves, fittings, studs, hose, packings, tubular products, and many others—call Bethlehem Supply. We'll give your inquiries prompt attention.

BETHLEHEM SUPPLY COMPANY

General Offices: 21 E. Second St., Tulsa, Okla.

Subsidiary of Bethlehem Steel Corporation

BETHLEHEM STEEL

GHQ FOR REFINERY SUPPLIES

BY THE very nature of their service, check valves must be dependable. That Lunkenheimer Check Valves provide this kind of service is proved by innumerable installations, in plants large and small, throughout the nation.

Recognized by leading valve users as remarkably trouble-free, Lunkenheimer Check Valves provide positive reverse-flow protection over a much longer, lower-cost service life.

Your Lunkenheimer Distributor has a stock of Check Valves for your needs. Call on him for your original equipment, replacement, and repair valve requirements.

. . . More than 96 types of LUNKENHEIMER *Check Valves*

Available in sizes and materials to meet every service requirement.

From small Bronze 125 lb. S.P. to massive steel patterns for pressures up to 2500 lb. S.P.

Lunkenheimer Check Valves are described and illustrated in Circular Number 588. Ask your Distributor for a copy or write direct.

ESTABLISHED 1862
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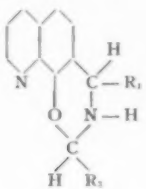
sion of the pour point and improvement of oxidation stability of the oil is effected by the additive. According to U.S.P. 2,459,113 an inert diluent is employed in reacting the said three reactants with one another, and the resulting condensation product is further reacted with a halide, thiohalide or sulfide of phosphorus. Oxidation is inhibited in the oil containing the additive thus obtained. The additive employed according to U.S.P. 2,459,114 differs from that according to U.S.P. 2,459,113 in that instead of the phosphorus compounds elementary sulfur, or a sulfur halide, or a mixture thereof is employed in the further treatment of the first condensation product to obtain a similarly acting additive. According to U.S.P. 2,459,115 the inorganic phosphorus compounds employed in U.S.P. 2,459,113 are used for corresponding treatment of an organic condensation product of complicated structure, e.g. a paraffin wax-hydroxy-benzyl morpholine, and in U.S.P. 2,459,116 the same type of organic condensation product is treated with inorganic sulfur compounds as named in U.S.P. 2,459,114. All these phosphorus or sulfur-containing additives inhibit oxidation of mineral oils containing them.

U.S.P. 2,458,526. Mineral Oil Composition. E. A. Oberright to Socony-Vacuum Oil Company, Inc.

A normally liquid hydrocarbon fuel oil fraction or a mineral lubricating oil fraction are compounded with a minor proportion of a condensation product of the formula:



wherein R_1 and R_2 are aryl radicals.

U.S.P. 2,458,527. Mineral Oil Composition. E. A. Oberright to Socony-Vacuum Oil Company, Inc.

A mineral oil is improved by an addition of a minor proportion of an oil-soluble condensation product obtained by reaction of an aldehyde, a hydroxy-aromatic carboxylic acid and a polyamine in which each amino group has at least one hydrogen atom.

U.S.P. 2,459,409. Method for Purifying Used Oils. C. R. A. M. Bjornstjerna to Aktiebolaget Separator, Stockholm.

Used oil, particularly lubricating oil, is continuously pumped through an endless circuit and heated in this circuit in a heating zone. The rate of flow of the oil from the source of supply shall be lower than that through the heating zone. Part of the circulating oil is continuously released and purified. Elimination of the impurities is considerably facilitated by the heating.

U.S.P. 2,459,717. Organic Lubricant Composition. G. L. Perry to Shell Development Company.

A mineral lubricating oil contains a minor amount of a saturated alkyl dibasic acid of at least 16 C atoms, e.g.

an alkyl succinic acid, and 0.01-0.1 percent by weight of a sulfurized unsaturated fatty acid with 8-26 C atoms, such as oleic acid. Corrosion and oxidation is inhibited by the additives.

U.S.P. 2,459,718. Lubricating Composition. E. R. Barnum and G. L. Perry to Shell Development Company.

A mineral lubricating or turbine oil contains 0.01-0.05 percent of sulfurized oleic acid with a sulfur content of 12.4-25.8 percent. The product is non-corrosive.

U.S.P. Re 23,082. Grease Compositions. J. C. Zimmer and G. W. Duncan to Standard Oil Development Company.

The grease composition comprises a lubricating oil and a thickening complex reaction product of an oil-soluble metal salt of sulfonic acid and a salt of a low mol. wt. aliphatic carboxylic acid. At least one of the cations of these salts shall be polyvalent. The complex reaction product is obtained by dissolving the sulfonate in the mineral oil and then reacting it with the other salt while heating.

U.S.P. 2,460,025. Lubricating Oil Composition. J. G. McNab and J. H. Bartlett to Standard Oil Development Company.

A mineral lubricating oil contains dissolved a small quantity of a compound of the formula RAr (XM) S_x(MX) ArR in which Ar is an aromatic hydrocarbon nucleus, R is a branched chain aliphatic hydrocarbon radical with 14-24 C atoms, X is a non-metallic element of group VI of the periodic table, M is the hydrogen equivalent of a metal, S is sulfur, and x is an integer from one to four. The additive stabilizes the oil against oxidation.

U.S.P. 2,460,041. Lubricating Composition. W. J. Sparks and D. W. Young to Standard Oil Development Company.

A mineral lubricating oil contains dissolved a copolymer of a diolefin with 4-14 C atoms (e.g. butadiene) and an isoolefin (e.g. diisobutylene), treated with a phosphorus sulfide to incorporate P and S therein. Extreme pressure properties are imparted to the composition by the additive.

U.S.P. 2,460,301. Lubricating Oils. B. H. Lincoln and G. D. Byrkit to The Lubrizol Development Corporation.

Lubricating oil is combined with a minor proportion of an oil-soluble halogen-containing organic phosphorus compound of the formula R — N : P (Q)$_n$ where R is a radical of benzenoid structure, N is trivalent nitrogen, Q is a halogen, and n is 1 or 3. The additive stabilizes the oil against oxidation. Phosphazo benzene chloride is an example of the additive.

U.S.P. 2,460,632. Spark Plug Thread Lubricant. B. Folda, Jr. to Socony-Vacuum Oil Company, Inc.

A spark plug thread lubricant comprises 30-50 percent by weight of graphite, 0.5-5.0 percent of an oil-soluble hydroxy heterocyclic amine of a mol. wt. of 300-400, and the remainder a naphthene-base lubricating oil.

U.S.P. 2,461,115. Method of Dewaxing Oils. C. F. Holm and B. K. Engel to Aktiebolaget Seperator-Nobel.

Stand-by Protection!

KOHLER

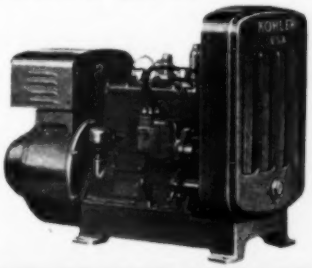
Electric Plants

safeguard against delays and loss when storms cause power failure

Suddenly, and without warning, the central station electric current serving your refinery may be cut off as a result of a storm, flood, fire, strike or other mishap. The consequences can be costly unless you have an efficient source of stand-by current.

Many refineries, including the world's largest, have installed Kohler Electric Plants to assure emergency lighting and uninterrupted operation of control instruments, alarm signals and other important motor driven equipment. Kohler Electric Plants take over the load in emergency without delay and without human attention—running for days if necessary.

Kohler Electric Plants are rugged, reliable, economical, easy to install and care for. The value of their stand-by protection has been proved in factories, schools, stores, hospitals, theatres, homes, and other places throughout the nation. Sizes 750 watts to 10 KW. Write for illustrated folder D-15. Kohler Co., Kohler, Wisconsin. Established in 1873.



Kohler Electric Plant 3A21, 3KW, 115 volt, AC. Automatic start and stop. Length 41", Width 16", Height 27¼".

KOHLER OF KOHLER

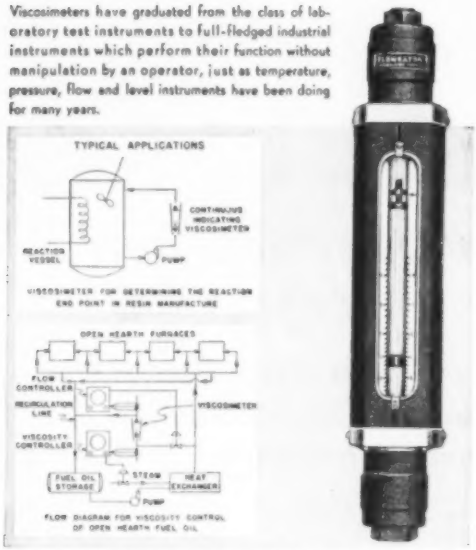
PLUMBING FIXTURES • HEATING EQUIPMENT • ELECTRIC PLANTS

VISCOSITY MEASUREMENT

CONTINUOUSLY AUTOMATICALLY

(and with automatic control of the viscosity, if desired) RIGHT IN THE PIPE LINE, WITHOUT WITHDRAWAL OF FLUID SAMPLES, WITHOUT STOP-WATCH READINGS OF EFFLUX TIMES NOW AN ACCOMPLISHED FACT

Viscosimeters have graduated from the class of laboratory test instruments to full-fledged industrial instruments which perform their function without manipulation by an operator, just as temperature, pressure, flow and level instruments have been doing for many years.



PRINCIPLE OF OPERATION

Continuous viscosimetry has been accomplished by utilizing one of the unique properties of the F & P FLOWRATOR meter (formerly rotameter):ability to make metering floats either viscosity sensitive or viscosity immune. Into one FLOWRATOR are placed two metering floats, the one so shaped that it is very viscosity sensitive, the other one with the patented F & P viscosity immune shape. When fluid flows upward through the tapered metering tube both floats will, of course, rise in the normal manner. However, the elevation of the one float will be relatively slight, since it is produced solely as a function of fluid flow rate. The other float elevation will be much greater since it is a function both of viscous drag and flow rate. The space increment thus created between the two floats is a direct measure of viscosity. By selecting any particular flow rate which will give a convenient elevation of the one float to serve as a reference line, the other float elevation may be marked as viscosity graduations in terms of centipoises, centistokes, S.S.U. or any other desired units. Viscosity measurement all the way from .0008 to 800,000 centipoises is now possible.

Write for catalog 88 giving much additional information. F&P VISCORATOR continuous viscosimeters have been thoroughly tested in trial installations for well over a year.

FISCHER & PORTER CO.
D PT. OP-1C HATBORO, PA.
FLOWRATOR
TRADEMARK

Wax-bearing mineral oil is chilled in a plurality of stages in countercurrent heat-exchange relation to a flowing heat-absorbing liquid. Wax and substantially wax-free oil are separated from the chilled oil. The substantially wax-free oil is utilized as a heat-absorbing liquid in all stages. Wax-free oil is withdrawn from the heat-exchange system, separately cooled and mixed at a point between two of the stages with the wax-free oil separated from the chilled oil.

U.S.P. 2,461,453. Manufacture of Lubricating Oil. F. C. Toettcher and J. R. Coley to The Texas Company.

Lubricating distillate oil is refined by solvent and acid treatment and neutralization. The resulting product which has emulsion resistant properties is further treated to make it suitable as a turbine oil. It is contacted with not less than 10 percent of activated clay at a temperature of 650-750° F. for about ¼-1 hour. The reactions thereby effected involve an increase in aromaticity and the formation of structures which inhibit oxidation without impairing the emulsion resistant property of the resulting turbine oil.

U.S.P. 2,461,454. Manufacture of Lubricating Oil. F. C. Toettcher to The Texas Company.

After separating from lubricating oil of the pale oil type a higher boiling minor fraction (about 10-25 percent of the oil), this fraction is treated with activated clay under similar conditions as described in U.S.P. 2,461,453. Lower boiling constituents are removed from the treated fraction by distillation to concentrate the oxidation inhibiting constituents. The resultant stripped product is blended with the untreated major fraction of the lubricating oil to obtain a lubricating oil of increased oxidation stability.

Memorial at Marcus Hook

A memorial honoring the 141 men of Sun Oil Company who lost their lives aboard tankers sunk or damaged during World War II will be erected at the entrance to the company's Marcus Hook refinery.

Names of the men who died at sea following German submarine attacks will be inscribed on bronze plaques on the sides of a granite pedestal supporting a bronze statue of a seaman.

Names of the four Sun tankers sunk by Nazi torpedoes will show on the plaques. Stone benches along a flagstone walk from the entrance gate will bear the names of Sun tankers which saw war service.

Kuljian Names Lundgren

The Kuljian Corporation, Philadelphia, has appointed Edwin Lundgren as its Washington, D. C., representative, effective January, 1949. His offices are located at 1415 K Street, N. W.

Petroleum Sunday Plans

The eighth annual Petroleum Sunday will be observed this year on April 24. Sponsored by the Catholic Petroleum Guild, the nation-wide observance is non-denominational. Prayers will be directed to give the industry divine protection so it can continue to promote progress and remain an outstanding industry in the United States.

BUY . . . .

CALITE HEAT ENDURING CASTINGS

to

DEFINITE CHEMICAL AND PHYSICAL SPECIFICATIONS

This Will Assure Uniform Quality and Service

STANDARD SPECIFICATION NO. 10-38

Heat Enduring Castings
For Industrial Furnace Construction
Grade "F"

CHEMICAL COMPOSITION:

(a) The castings shall conform to the following requirements as to chemical composition:

	GRADE "F"
Chromium, per cent	25.0–28.0
Nickel, per cent	10.0–12.0
Manganese, per cent	0.50–1.25
Silicon, per cent	0.25–1.75
Sulphur, maximum per cent	0.05
Phosphorous, maximum per cent	0.05
Carbon	Within limits of Paragraph 4 (c)

(b) The chemical limits for all other added alloying elements, such as molybdenum, titanium and nitrogen, shall be specified by the manufacturer. The material shall conform therewith.

CREEP STRESS AND CERTIFICATE:

(a) The indicated creep rate of the material shall not exceed 1% in 10,000 hours when stressed by a tensile load not less than the following:

TEMP. °F.	STRESS PER SQ. IN. 1% CREEP IN 10,000 HOURS GRADE "F"
1400°	4200#
1500°	3700#
1600°	3200#
1700°	2600#
1800°	1950#

(b) Manufacturer shall submit standard creep data and residual physical properties made on material of his own manufacture and certified by an ACCREDITED LABORATORY. The chemical analysis of the creep test specimens shall be reported, including nitrogen content and any other special alloying elements.

TENSION TEST FOR DUCTILITY AFTER HEATING:

(a) Each heat shall conform to the following requirements as to tensile properties after the specimen has been subjected to a temperature of 1400° F. for 24 hours and furnace cooled to 400° F. Test shall be made at room tmperature.

	GRADE "F"
Tensile Strength, min.lb./sq.in.	80,000
Yield Strength, min.lb./sq.in.	35,000
Elongation in 2", min. per cent	9.0

Copy of complete specification will be mailed upon request.

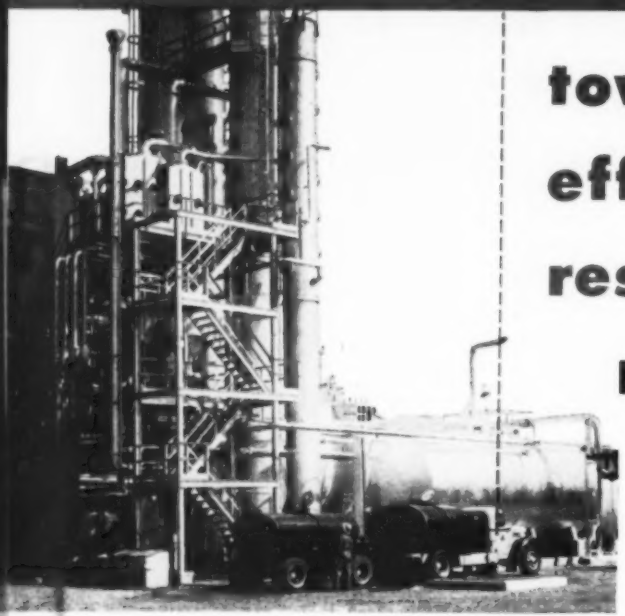
THE CALORIZING COMPANY

HEAT ENDURING AND CORROSION RESISTING METALS.
CALITE ALLOY CASTINGS — CALORIZED STEELS.

WILKINSBURG STATION **PITTSBURGH 21, PA.**

DOWELL

SPECIALISTS IN SCALE AND SLUDGE REMOVAL WITH CHEMICALS



tower efficiency restored-

by Dowell Service!

PACKED TOWERS, bubble towers, towers with grids or baffles—Dowell's tested Chemical Scale Removal Service has proven effective in cleaning all types. Accumulated scale and sludge have been removed rapidly and designed efficiency restored with a minimum of expensive outage time and inconvenience.

Dowell engineers select the proper liquid solvent designed to dissolve and disintegrate the deposit. Using equipment designed by Dowell, the solvents are pumped into the tower, filling it to capacity . . . or are pumped in at the top of the tower and allowed to flow down over the trays. Finally, the spent solvent is flushed out and the tower is ready to be put back into operation, usually within 24 hours.

Dowell service engineers do not require special scaffolding or the dismantling of the tower. Specially designed truck-mounted tanks, pumps, heaters, mixers, and control equipment necessary to do the job properly are brought right into your plant.

For the chemical cleaning of towers, cooling systems, heat exchangers, steam generating equipment, condensers, pipe lines, cooling jackets—call your nearest Dowell office for free cost estimate.

DOWELL INCORPORATED • TULSA 3, OKLAHOMA

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

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New York 20, Boston 16, Philadelphia 3, Baltimore 18, Wilmington 99, Richmond 19, Jacksonville, Atlanta, Buffalo 2, Cleveland 13, Pittsburgh 19, Detroit 2, Chicago 2, St. Louis 8, Indianapolis, Louisville, Kansas City 8, Wichita 2, Oklahoma City 2, Houston 2, New Orleans 12, Ft. Worth 2, Shreveport 23, Anniston, Alabama, Mt. Pleasant, Mich., Hamilton, Ohio, Charleston 27, W. Va., Salem, Illinois, Borger, Texas, Midland, Texas, Wichita Falls, Texas, Lafayette, La.

Long Beach, Oakland, Casper: Dowell Associate—International Cementers, Inc.

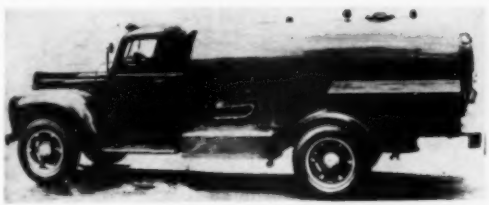
DOWELL

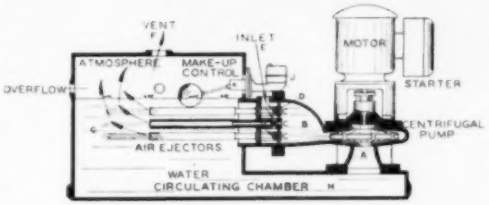
A SERVICE ORGANIZATION

NEW EQUIPMENT and Manufacturers' Literature

For copies of manufacturers' literature or more information on products described on these pages write to the address shown, using the number shown for each item.

Hydro-Scavenger Unit





Bulletin HS-49 describes the Whittington hydro-scavenger unit, "a time and service tested vacuum unit for cleaning gas main drips, gas service leads, pits, tanks, machinery sumps, diesel engines, etc." The unit was designed to handle and transport liquids of varying viscosity as well as sludges containing abrasives, fibers, metal chips, and other solids. It consists of the basic unit illustrated below and a collection chamber of heavy welded steel construction. The centrifugal pump takes water up at A, discharges it B, under pressure at high velocity through brass nozzles C and venturi throats. This induces flow of air through ports D from the air inlet E, creating a suction at this point. Air passes through the submerged jets and is vented to atmosphere at F. Water is recirculated through the tank G and extension H to repeat the cycle. The pump is claimed to develop and maintain 27 inches mercury vacuum even after many years of service. The hydro-scavenger is available in truck, trailer, skid and castor models, powered by electric or gasoline motors.

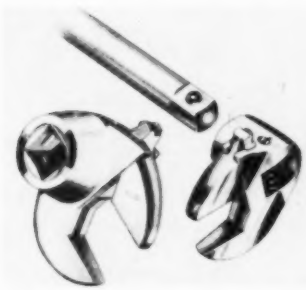
For further information, write Whittington Pump & Engineering Corporation, 1126 Prospect Street, Indianapolis 3, referring to PETROLEUM REFINER item **151.**

Safety Valve

In order to meet operating requirements of high pressure, high temperature steam generating equipment, Manning, Maxwell & Moore, Inc., has introduced a new safety valve, the Consolidated Maxiflow. Designed to function with a blowdown as low as one percent, the trim ring of the blowdown controls provides "a controlled steam by - pass around the outer ring or deflector, making it possible to regulate the reaction effect required." The Consolidated thermodisc seat design has been incorporated in the Maxiflow valve. The through-bushing design, associated with Consolidated safety valves since their inception, "eliminated possible difficulties due to porous body castings." The valve can be easily disassembled and the spring load can be retained during disassembly.

For further information write Manning, Maxwell & Moore, Inc., 11 Elias Street, Bridgeport 2, Conn., referring to PETROLEUM REFINER item **154.**

Adjustable Crowfoot Attachments



Through the medium of one tool and its adjustable crowfoot attachments, J. H. Williams & Company has combined "the flexibility of the detachable socket system with all the advantages of the open end adjustable wrench." The attachments are available in two square-drive sizes, ⅜- and ½-inch, with capacities of ¾ and 15/16 inch, respectively. Square shoulders on the body portion of the sliding jaw "provide maximum and positive bearing against working stress."

For a copy of Booklet *A*-50 write J. H. Williams & Company, 400 Vulcan Street, Buffalo 7, N. Y., referring to PETROLEUM REFINER item **152.**

Turbine Pumps

A new line of medium duty turbine pumps, designed by Roy E. Roth Company, "provides a low priced line for use in water supply service, condensate return and boiler feed service or any application where non-viscous and non-abrasive liquids are handled against moderate pressures." Capacities available are 2 to 10 gallons per minute and 20 to 100 head feet in water at 1750 rpm. or 2 to 8 gpm. and 100 to 200 head feet in water at 3450 rpm. The only moving part of the pump is the impeller mounted on a stainless steel shaft, which turns on two ball bearings.

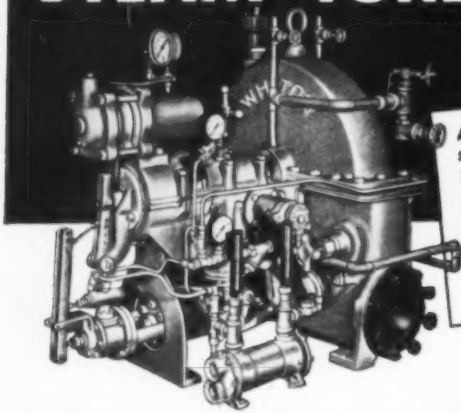
For further information write Roy E. Roth Company, Rock Island, Ill., referring to PETROLEUM REFINER item **153.**

Hydraulic Dynamometer

Hydraulic dynamometers, designed, built and used by Wagner Electric Corporation, are available "where accurate load-testing of motors is necessary." It may be used with idle, pull-in,

Whiton SOLID STEEL ROTOR

STEAM TURBINES



Available in single stage types up to approximately 1200 HP rating. Center supported frames are available when required.

SIMPLE DESIGN FOR ACCESSIBILITY

Inlet and exhaust connections are located in lower half of casing which is horizontally split to allow easy access to all internal parts. Rotating unit including governor head may be removed without disturbing alignment of the unit.

RUGGED CONSTRUCTION FOR RELIABILITY

Whiton rotors are made from a solid steel forging with semi-circular buckets milled in the rim to give strength where it is needed. End thrust is minimized because the path of the steam is always at right angles to the shaft.

Ejector Shaft Packings assist in eliminating steam leakage to the oil reservoirs. They require a minimum of maintenance.

Whiton Turbine Bearings are horizontally split for easy removal. They consist of bronze or semi-steel shells with babbitt liners, precision fitted at the factory.

Nozzle block with reversing chamber is solidly mounted on turbine casing steam chest. It utilizes power to the utmost by redirecting steam jet with a circular action into rotor buckets.

SAFETY GOVERNING DEVICES FOR TROUBLE-FREE OPERATION

Standard equipment includes Constant Speed Governor with V-Ported Governor Valve — Emergency Governor with Independent Valve — Steel Plate Steam Strainer — Two oil rings per bearing supplemented by water cooling — Sentinel Type Casing Relief Valve — Additional accessories available as required.

Whiton Steam Turbines are under continuous rigid inspection during every step of their manufacture.

THOUSANDS OF SATISFACTORY INSTALLATIONS

Write for complete information

WHITON MACHINE COMPANY

NEW LONDON, CONN., U.S.A.

also makers of Fine Lathe Chucks • Gear Cutting Machines • High Production Milling Machines • Centering Machines

pull-up, full-load and locked tests. The dynamometer is foot controlled. The foot-pounds of torque can be read directly from the gauge supplied with the instrument. Capacities range from 30 to 300 foot-pounds.

For further information write Wagner Electric Corporation, 6488 Plymouth Avenue, St. Louis 14, referring to PETROLEUM REFINER item **155.**

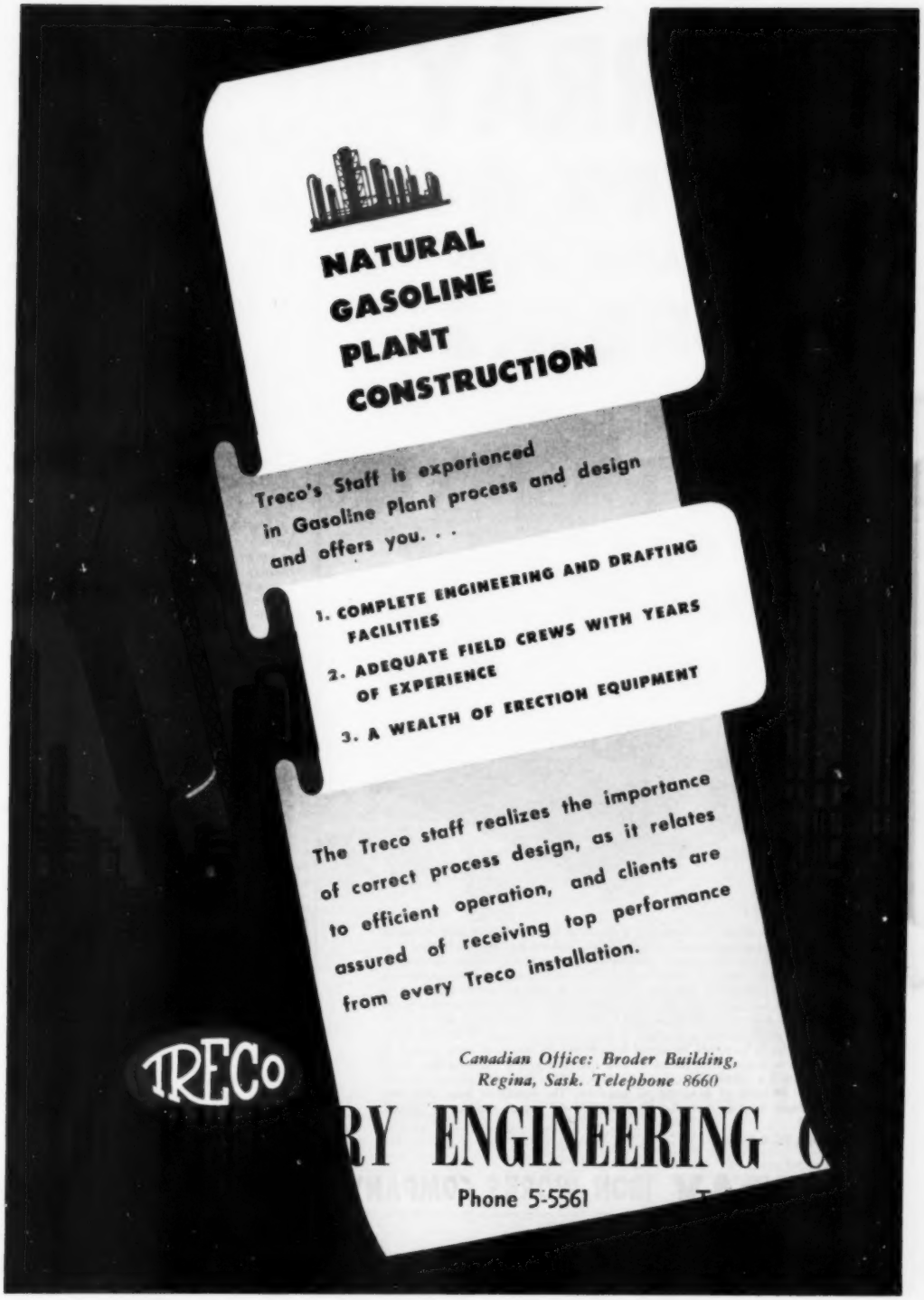
Axial Flow Pumps

Economy Pumps, Inc., has a new "pull-out" model in axial flow and mixed flow type pumps designed so that all working parts are removable without breaking discharge connections and recommended "for power plant condenser circulation and for other continuous operations where it is desirable to disengage all working parts for inspection without breaking pipe or mounting connections, when the discharge elbow is below floor level, and when the pit in which the pump is installed is not easily drained." The pump is available in capacities up to 100,000 gpm.

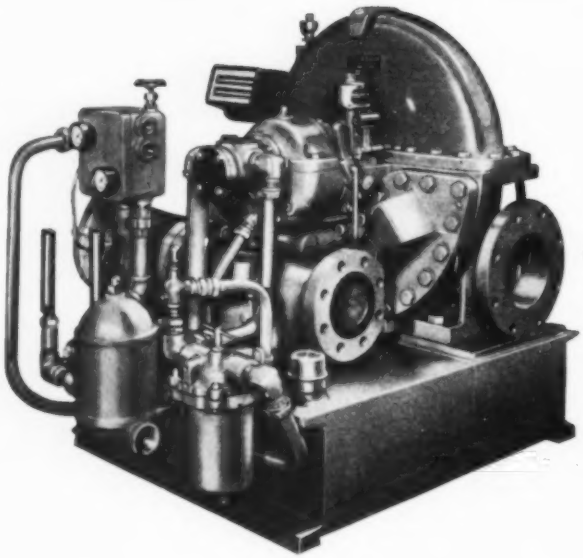
For further information write Economy Pumps, Inc., 1000 Weller Avenue, Hamilton, Ohio, referring to PETROLEUM REFINER item **156.**

Explosion-Proof Heater

Claimed to be the first all electric explosion proof heater made to comply with Underwriters' Laboratories Class I, Group D, Hazardous Locations, Electromode Corporation's heater is especially designed "for use in atmospheres containing gasoline, petroleum, naphtha, acetone, benzol, lacquer, solvent vapors and natural gas," etc. The heating element used consists of a nickel chromium resistor wire, completely sealed. The aluminum grid remains at a low operating temperature, but has high thermal conductivity. The unit may be thermo-


NATURAL
GASOLINE
PLANT
CONSTRUCTION
Treco's Staff is experienced
in Gasoline Plant process and design
and offers you. . .
1. COMPLETE ENGINEERING AND DRAFTING FACILITIES
2. ADEQUATE FIELD CREWS WITH YEARS OF EXPERIENCE
3. A WEALTH OF ERECTION EQUIPMENT
The Treco staff realizes the importance of correct process design, as it relates to efficient operation, and clients are assured of receiving top performance from every Treco installation.
TRECo
Canadian Office: Broder Building,
Regina, Sask. Telephone 8660
RY ENGINEERING
Phone 5-5561

MURRAY
TYPE S
VARIABLE SPEED
TURBINE



Murray Type S Steam Turbines are well suited to a variety of jobs including those drives requiring variable speed. These turbines may be constructed with hydraulic type variable speed governors and complete pressure lubrication system including reservoir, filter, cooler, oil pressure gauges and thermometers. Turbines so equipped are not only suitable for variable speed operation but for higher operating speeds as well. These features make the Type S variable speed turbine an ideal drive for high speed centrifugal compressors and blowers.

Pictured above is such a machine designed to deliver 400 HP at 7400 RPM. This machine is arranged for speed adjustment by means of hand control or by automatic control. The turbine is also equipped with a vibrating type speed indicator and a remote control tripout device. Note that the construction provides an oil tank of generous oil capacity. The combined base and tank arrangement may be extended for mounting the driven machine if desired.

Write today for full details.

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

statically controlled through a contactor, and is available in models with ratings of 2000, 4000 and 6000 watts.

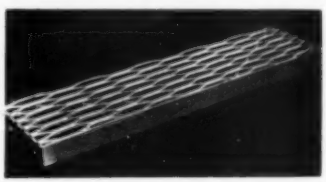
For further information write Electromode Corporation, 45 Crouch Street, Rochester 3, N. Y., referring to PETROLEUM REFINER item **157.**

Floor Machine

An explosion-proof machine for automatic scrubbing, cleaning and polishing of floors in hazardous areas is announced by Multi-Clean Products, Inc. All equipment and components used in the manufacture of the MC-EX floor cleaning machine have been listed by Underwriters Laboratories for use in hazardous areas. The General Electric motor, flexible coupling and totally enclosed safety switch are featured. The dual-ac, 110 or 220-volt capacitor induction type motor is 1/3 hp. for the 14-inch machine and ¾ hp. for the 16-inch machine. The heavy duty cord is a three-conductor type with a ground jack. The adjustable handle and the center balance combine to assure easy operation. Flip up wheels require no lubrication. Bronze castings are used at all points of strain.

For further information write Multi-Clean Products, Inc., 2277 Ford Parkway, St. Paul 1, Minn, referring to PETROLEUM REFINER item **158.**

Anti-Skid Stair Tread



Wheeling Corrugating Company has developed a stair tread in two designs, one for general use and the other for dangerous, slippery conditions. The anti-skid tread has a patented safety finish on top "which makes slipping practically impossible and yet is comfortable under foot."

For further information write Wheeling Corrugating Company, Special Products Division, Wheeling, W. Va., referring to PETROLEUM REFINER item **159.**

Drumobile

Drumobile, an improved three-wheeled carrier manufactured by Ernst Drumobile Division of Brantwood Products, Inc., is designed "to lift, transport and release any size or type of steel drum, wood barrel or cylindrical fibre container." It can pick up containers with loads up to 850 pounds in 50 to 60-gallon sizes, carry them in a level upright position and deposit them without tilting them or having them touched by a worker's hand. The carrier is little wider than the drum and the level-handle, after serving to lift the load and

actuating the safety lock, becomes a free-swinging steering column adapting itself to any desired height. Neither the gripping mechanism nor any other part of the vehicle "will dent or puncture any container." The device employs no motors, batteries or switches.

For further information write Ernst Drumobile Division of Brantwood Products, Inc., 115 Brayton Street, Buffalo 13, N. Y., referring to PETROLEUM REFINER item **160.**

Steam Separators

Wright-Austin Company's new catalog describes 29 types of separators which are supplied in more than 145 sizes in the pipe size range of ½ to 16 inches. Particular attention is given to the company's welded "Standard Special" steel receiver-separators which are "steam separators built from standardized parts in special construction to overcome unusual operating conditions or to fit piping arrangements demanded by structural limitations at point of installation." Charts, tables and diagrams help to select the type and size of separator needed.

For a copy of the catalog write Wright-Austin Company, 315 West Woodbridge Street, Detroit 26, Mich., referring to PETROLEUM REFINER item **161.**

Anti-Corrosion Fittings

Electric Steel Foundry Company has increased its line of products to include fittings and cenrifugally cast pipe up to 14 inches IPS. Standard IPS and flanges specifications are cast in Esco Alloy 20. Resistant to nitric-sulfuric acid mixtures, the alloy contains "sufficient nickel to hold the copper in solution. The chromium and molybdenum contribute additional resistance to oxidizing acids and the analysis of the resulting alloy is an austenitic stainless steel having the physical properties of the 18-8 group." Bulletin 165-A gives information on available products. Bulletin 166 gives the properties of Alloy 20.

For a copy of the bulletins write Electric Steel Foundry Company, 2141 North West 25th Avenue, Portland 10, Ore., referring to PETROLEUM REFINER item **162.**

Planning Plant Construction

In a new booklet, "Packaged Plant Construction . . . a Complete Service from Planning to Production," Wigton-Abbott Corporation outlines the manner in which "specialized and complex functions are performed and coordinated to produce a modern industrial or process plant from conception of design to completion of construction and delivery."

For a copy of the booklet write Wigton-Abbott Corporation, 1225 South Avenue, Plainfield, N. J., referring to PETROLEUM REFINER item **163.**

Plastic Paint

CycLon, a line of corrosion resistant plastic coatings for the protection and maintenance of processing equipment including pipe and storage tanks, has been developed by The Poly-Cyclo Products Company. Munray Products, Inc. will handle the product. An inexpensive, easily applied, high solids synthetic paint, it "protects metals, wood and ceramic surfaces against chemical attack by corrosive fumes, condensates, spiller, etc." CycLon air dries quickly by solvent evaporation to an "adhesive, hard working, flexible glossy coating without the necessity of priming the surface being coated." It has a coverage of 350 to 450 square feet of area per gallon per coat and coatings are "unaffected by all alkalies as well as by their salts and by most mineral acids, and are inert to alcohols, soaps, water, oxidants, food and fruit acids, oils, aliphatic hydrocarbons, gasoline (low octane) and many other corrosive reagents."

For further information write Munray Products, Inc., 12400 Crossburn Avenue, Cleveland 11, Ohio, referring to PETROLEUM REFINER item **164.**

High Vacuum

Distillation Products, Inc., is offering a new bulletin on current developments in the field of high vacuum. "The Measurement of Low Pressures" is discussed by B. B. Dayton. Featured also is the art of blowing an intricate high-vacuum pump from glass tubing.

For a copy write Distillation Products, Inc., 755 Ridge Road West, Rochester 13, N. Y., referring to PETROLEUM REFINER item **165.**

Anhydrous Hydrofluoric Acid

The Harshaw Chemical Company's new booklet on anhydrous hydrofluoric acid lists its physical properties and cites materials and equipment suitable for use in handling HF, these including valves, pumps, gauges, pipe and fittings and meters. General precautions and general treatments are explained. Discussions of the alkylation of isoparaffins with olefins and HF as a condensing agent and fluorinating agent are included.

For a copy of the booklet write The Harshaw Chemical Company, 1945 East 97th Street, Cleveland 6, Ohio, referring to PETROLEUM REFINER item **167.**

Chlorine Dispenser

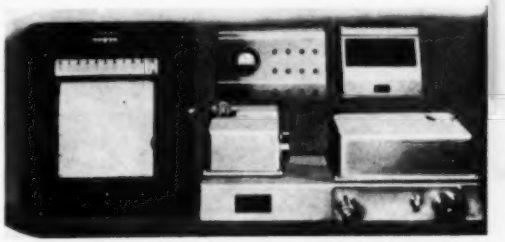
Fischer and Porter Company has developed a new Rato-Chlor "dry vacuum" chlorine dispenser. Chlorine is filtered to remove possible gum-forming hydrocarbon impurities and then delivered to the dispenser at a controlled pressure of minus 20 inches of water. Flow rate is set by a packless, needle-type regulating valve and is measured by a flowrator meter calibrated to indicate pounds per day of chlorine vapor. A differential pressure regulating valve completes the flow control element. Vacuum is created by an ejector and kept uniform by a vacuum regulating valve. The ejector also mixes a dilute chlorine-water solution which it discharges through a distributor into the stream being chlorinated. A vacuum operated shutoff valve automatically interrupts the flow of chlorine in the event of leakage. Flow is also interrupted when the ejector supply water is shut off. The dispensers are produced in 17 standard sizes ranging from a minimum capacity of ten pounds per day to a maximum capacity of 7500 pounds per day. Minimum capacity is 1/10 maximum.

For a copy of Bulletin 1C-P write Fischer and Porter Company, Hatboro, Pa., referring to PETROLEUM REFINER item **168.**

Infrared Analyzer

The new infrared analyzer of The Perkin-Elmer Corporation has been developed for continuous automatic analysis of as many as six different components in a flowing stream of sample. The stream may be either in the liquid or gas phase. Cycling time for a six-component analysis is about six minutes. The instrument consists of an infrared monochromator, automatically driven turret, a recorder automatically synchronized with the turret and an amplifying circuit. Operating variables such as temperature, contact time, flow rate, etc., may be "varied continuously and evaluated immediately from the automatic analytical record." In a continuous multi-stage process, sampling may be performed at intermediate stages for independent evaluation.

For further information write The Perkin-Elmer Corporation, Glenbrook, Conn., referring to PETROLEUM REFINER item **166.**



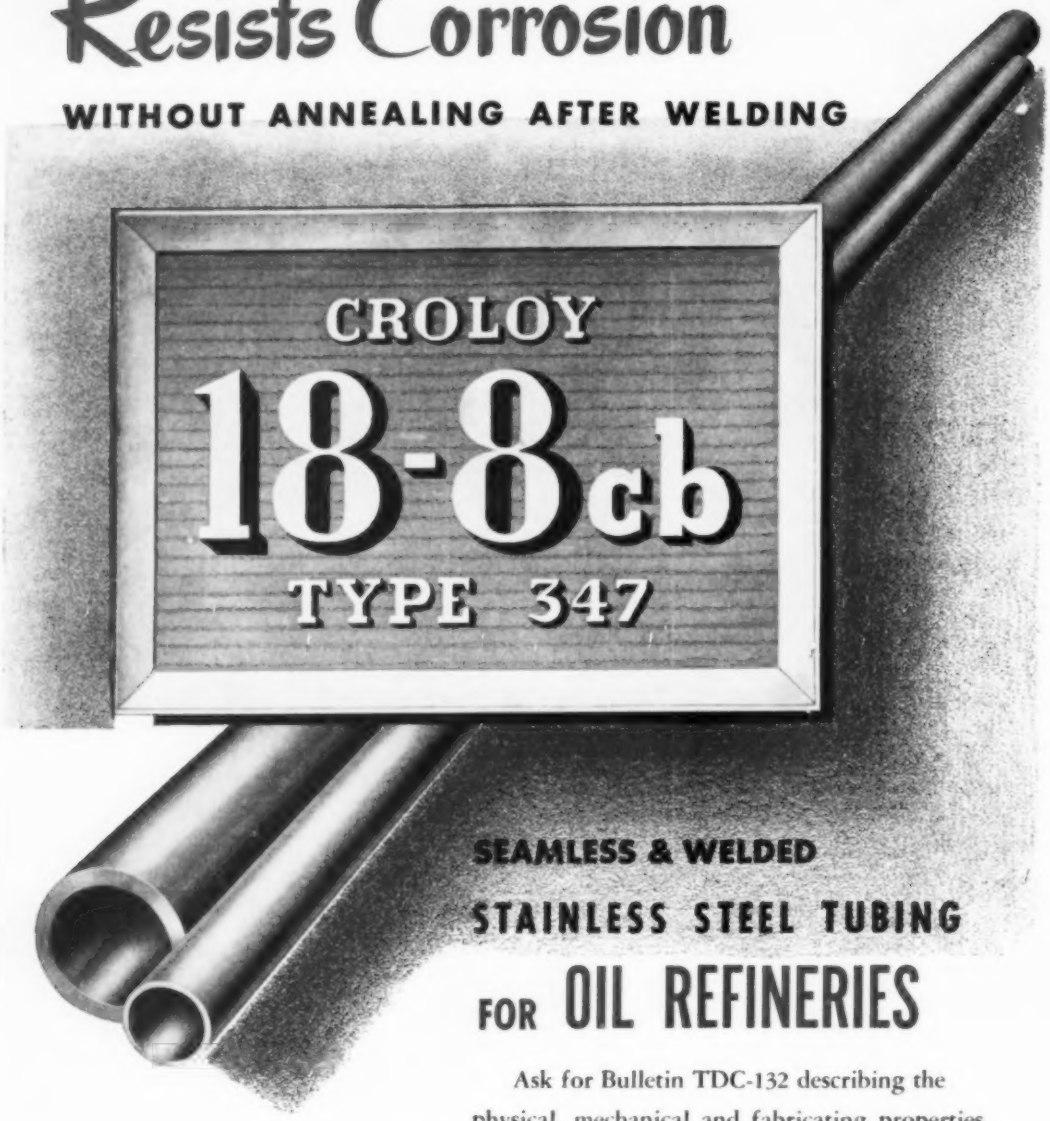
New Infrared Analyzer

Electronic Timer

An automatic timer for intervals from 1/20 second to four minutes, the electronic timer of Photoswitch, Inc. is recommended "for process control and machine timing when long life repeat-cycle operation or precise accuracy is a prerequisite." Type 30HL1 provides interval, delayed action, automatic repeat and programming timing. The electrical circuit of the switch has high flexibility by bringing out many points of the circuit to terminals on the front panel. The basic circuit has been de-

Resists Corrosion

WITHOUT ANNEALING AFTER WELDING



SEAMLESS & WELDED

STAINLESS STEEL TUBING

FOR OIL REFINERIES

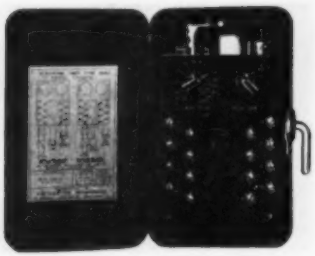
Ask for Bulletin TDC-132 describing the physical, mechanical and fabricating properties.

TA-1466-S

THE BABCOCK & WILCOX TUBE COMPANY
General Offices: Beaver Falls, Pa.
Plants: Beaver Falls, Pa., and Alliance, Ohio

BABCOCK & WILCOX SEAMLESS & WELDED TUBES

A full range of Stainless, Alloy and Carbon Steel Tubing for all Pressure and Mechanical Applications



signed to self-compensate for changes in line voltage. Either 115V or 230V supply line can be used. The timer employs only one tube and one relay.

For further information write Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass., referring to PETROLEUM REFINER item **169.**

Chlorine Technical Manual

A new technical manual, "Chlorine," prepared by the Columbia Chemical division of Pittsburgh Plate Glass Company, is the second of a series and follows the Columbia Caustic Soda manual. Charts, diagrams and photographs concerned with the production and handling of chlorine and its end-products are presented in the data book. Highlights in the history and growth of the industry are traced. Methods of manufacture, handling, unloading, safety precautions, shipping, equipment and construction materials are also included as are properties of chlorine, the preparation and analyses of bleach liquors and conversion information.

For copies of the technical manual write Pittsburgh Plate Glass Company, Fifth Avenue at Ballefield, Pittsburgh 13, referring to PETROLEUM REFINER item **170.**

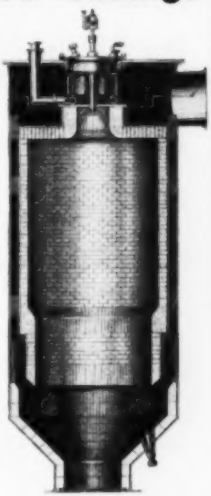
Steam Trap Problems

Information to aid the user in selecting the right size steam trap and in following correct trapping practice is contained in the new booklet published by The V. D. Anderson Company. It gives trap capacity factors, how to determine the lift of a trap and condensation rates. Trapping practices and theory, installation, operation and maintenance are explained. The Super-

for peak efficiency

on high-pressure furnaces

with sustained loadings



PEABODY Direct Fired Air Heater and Burner Units are in service throughout the petroleum industry in every part of the world. Proof that these Peabody units operate to our client's entire satisfaction in various refinery operations is evidenced by the many duplicate installations that we've made for these same clients.

Peabody designs and builds Direct Fired Air Heater and Burner units for operating pressures ranging from atmospheric to 125 lbs. psia and outlet temperatures ranging up to 1800° with firing rates to 100,000,000 BTU per hour. *Specific performance and engineering proposals on request. No obligation.*

HIGH-PRESSURE BURNERS—specially constructed for firing high-pressure furnaces to give dependable performance with special emphasis on stable operation at all times. These burners are designed to burn either gaseous or liquid fuels or both fuels in combination. Wide flexibility permits regulation by simplified central control system.

BLAST FURNACE GAS BURNER
REFINERY BURNER FOR GAS AND OIL
COMBINED GAS AND OIL BURNER
COMBINED COAL AND OIL BURNER
GAS SCRUBBER COOLERS, ABSORBERS
FUEL OIL PUMP AND HEATER SET'S

PEABODY
ENGINEERING CORPORATION
580 FIFTH AVENUE • NEW YORK 19, N. Y.
Manufacturers of all types of combustion equipment, direct-fired air heaters, gas scrubbers, coolers, and absorbers

OFFICES IN PRINCIPAL CITIES 222

Silvertop steam trap and its features, plus details of simplified piping for steam traps are described. Descriptions of Anderson float traps, air release valves and pipe line strainers are also included.

For a copy of the booklet write The V. D. Anderson Company, 1935 West 96th Street, Cleveland 2, Ohio, referring to PETROLEUM REFINER item **171.**

Plastic Fire Brick

Walsh Refractories Corporation has published a bulletin, "Here's Longer Life for Your Furnace Linings" which describes the company's new plastic fire brick.

For a copy write Walsh Refractories Corporation, Department P-2, 4070 North First Street, St. Louis 7, Mo., referring to PETROLEUM REFINER item **172.**

Dial Manometer

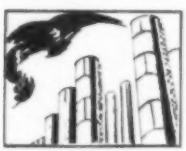
New models and recent improvements in the precision dial manometer of Wallace & Tiernan Products, Inc., are described in Bulletin TP-30-A. Standard ranges are 0 to 120 inches of water or of mercury. Special ranges up to 200 inches of mercury are custom-built. The scale is supplied in any desired pressure equivalent and is 45 inches long.

For a copy of the bulletin write Wallace & Tiernan Products, Inc., Belleville 9, N. J., referring to PETROLEUM REFINER item **173.**

Sheffield

ALUMINUM TANK PAINT

Laboratory Tested



Extensive weather-o-meter tests prove this NEW aluminum paint will resist more than one and one-half years exposure to weather extremes! Formulated to do TWO specific jobs—to protect surfaces against rust, wear and corrosion . . . and to add a long lasting attractive finish . . . Sheffield TANK PAINT has been made especially to overcome the expensive maintenance and finishing problem facing the oil industry.

- Made of only the finest, uniform aluminum linings — top quality!
- Formulated with a special long oil alkyd synthetic resin vehicle in conjunction with other synthetic resin. These give a high resistance to abrasion and chemical fumes.
- Covers all primed surfaces in ONE COAT, giving a tough, elastic durable finish . . . actually a coating of finest aluminum.

Write for descriptive folder . . . prices and samples sent upon request.

THE SHEFFIELD BRONZE PAINT CORPORATION

17814 WATERLOO ROAD • CLEVELAND 19, OHIO

One of the World's Largest Manufacturers of Aluminum Paints and Paint Specialties

Industrial Box Furnace

Cooley Electric Manufacturing Corporation is offering a new series of industrial box furnaces. The resistors are embedded in ceramic slabs and placed in the side walls so as to leave on air space around the slab, which serves as a baffle wall, creating a natural convection when heated. The door of the furnace completely covers the operating end and is insulated equally with the other furnace walls. It is vertically operated and consists of a counterweighted yoke which pivots on antifriction bearings, "making it possible to raise it to the full limit and replace new heating elements without disturbing any mechanical parts of the furnace." Lengths are 18, 24 and 36 inches with power inputs of 11.5, 14 and 18 kw.

For further information write Cooley Electric Manufacturing Corporation, 38 South Shelby Street, Indianapolis 7, Ind., referring to PETROLEUM REFINER item **174.**

Mineral Wool Insulation

The new Commercial Standard, CS105-48, prepared by the Industrial Mineral Wood Institute and the National Bureau of Standards, defines the five forms of mineral wool used in low-temperature applications: loose, granulated, felt, industrial batt and board or block forms. Recommended specification requirements for thermal conductivity, density, moisture absorption, corrosive properties, odor and fire resistance of mineral wools as well as characteristics of auxiliary materials are given. Construction details include sections on vapor barrier, foundations, general construction and applications of the mineral wool or different surfaces. Tables show recommended thicknesses.

For a copy of the Standard write Industrial Mineral Wool Institute, 441 Lexington Avenue, New York 17, referring to PETROLEUM REFINER item **175.**

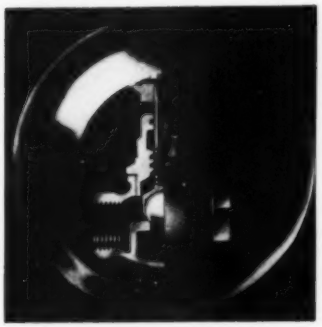
Galvanizing Compound

American Solder and Flux Company claims that its Amco galvanizing compound makes possible repairs on galvanized surfaces without removing the equipment from use. Available in sticks, bars and powder form, the product is rubbed or dusted on the heated surface after it has been cleaned and there

"amalgamates with the surrounding galvanized surface and the base metal, assuring the same protection as in the original galvanizing and preventing rust and corrosion."

For further information write American Solder and Flux Company, 2152 East Norris Street, Philadelphia 25, referring to PETROLEUM REFINER item **176.**

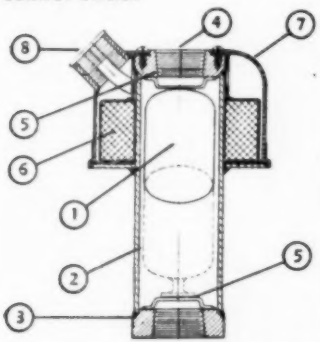
Ball Valve



Carpenter Manufacturing Company has placed a "precision ground stainless steel ball" in its "Bull-Dog" ball valve, "effecting a life-time seating member with harmless effect upon the seat." The ball is spun into its retainer allowing a slight clearance, which is claimed to permit the ball to spin when the valve is opened or closed, finding a new seat each time. Supplied with "O" ring seals for normal service where high temperature is not involved, the valve has conventional steam packing when installed in steam or other high-temperature service.

For further information write Carpenter Manufacturing Company, 9523 Detroit Street, Cleveland 2, Ohio, referring to PETROLEUM REFINER item **177.**

Control Switch

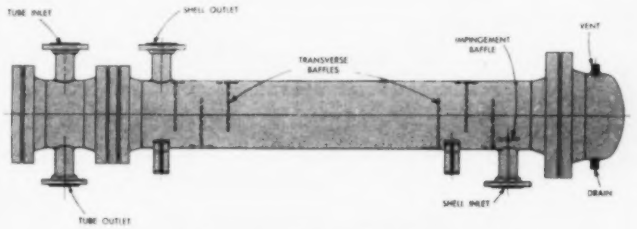


The new automatic liquid level control switch, the Acrafloat, manufactured by Clapp Instrument Company, is operated by a free buoyant float, encased in a vertical metal pipe "controlling and indicating liquid levels to a fraction of an inch within required vertical differentials of many feet, and applicable for controlling re-cycling processes in the chemical and oil refining industries and

B.T.U. *digest*

THROWING LIGHT ON HEAT TRANSFER PROBLEMS

THE WHITLOCK MANUFACTURING COMPANY
149 BROADWAY, NEW YORK 6, NEW YORK
Main Office and Plant, 75 South St., Elmwood, Hartford 2, Conn.
NEW YORK • CHICAGO • BOSTON • PHILADELPHIA • DETROIT • RICHMOND
In Canada: DARLING BROS., LTD., Montreal



WHITLOCK
STANDARDIZES FOR ECONOMY

As an example of Whitlock Standardization the construction of the ST Heat Exchanger will be of interest. A good bit of our engineering effort has been devoted to standardization for the purpose of avoiding costly "specials" wherever possible. One of the results of this program is illustrated by the wide range of Standard Type ST Heat Exchangers now available. The Whitlock Type ST is a straight-tube floating head (split ring design) exchanger. Units are available in 150# and 300# design pressures and can be furnished of all-steel construction or with steel shell and nonferrous tube bundle construction, replacing many special, more costly units.

Today the reduction of manufacturing costs is of vital concern to all manufacturers, and standardization —whether partial or full—is a big step in the direction of economy. Standardization helps reduce engineering costs, and also permits quantity purchasing—resulting in reduced material costs. Partial or whole prefabrication of major subassemblies, even with heavyweight heat exchangers, likewise means lower production costs.

Standardization of the Whitlock ST Heat Exchanger now allows the application of low cost standard units to special and individual operating conditions, and greatly expedites deliveries. This is very important to the customer since single units, series of units, and replacement parts as well, are available for early shipment.

APPLICATIONS

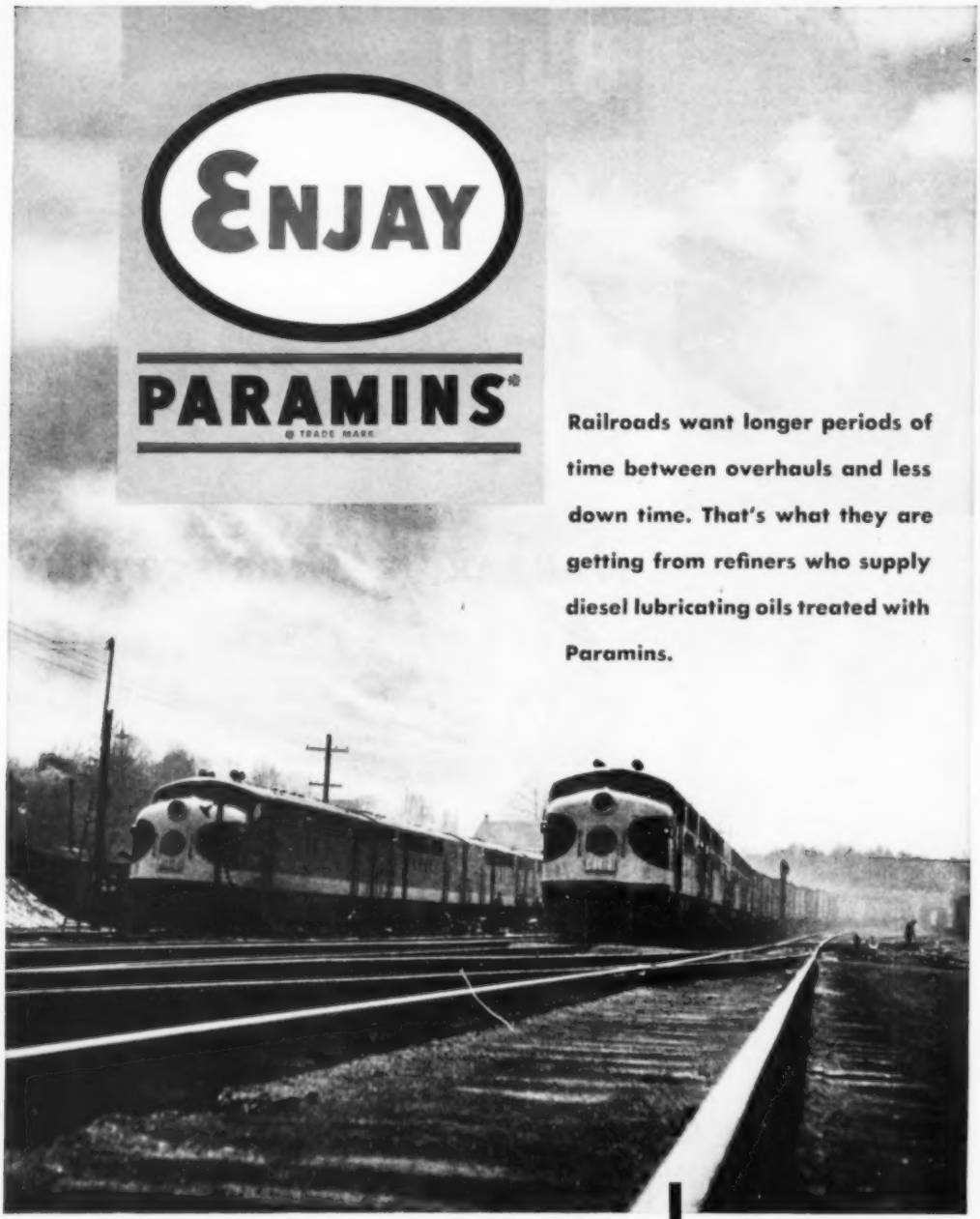
The Whitlock Type ST Heat Exchanger of straight tube floating head design (split-ring assembly) has large scale application to the typical refinery heat transfer problem. Whether the service calls for heating, cooling or condensing and whether the process fluids have viscosity characteristics of a light fraction or of a heavy tar, the unit has application because of its fundamental consideration of thermal design details, mechanical characteristics and maintenance requirements.

WHITLOCK

ENJAY

PARAMINS®

® TRADE MARK



Railroads want longer periods of time between overhauls and less down time. That's what they are getting from refiners who supply diesel lubricating oils treated with Paramins.

PARAMINS make good oils and fuels better!

PARATONE —for improved viscosity index. PARAFLOW —for lower stable pour. PARATAC — for tacky oils and greases. PARAPOID —for E. P. gear oils. PARANOX—for inhibiting corrosion and oxidation. PARASHEEN—for better appearance. PARADYNE —for improved gasoline.

ENJAY COMPANY, INC.
15 West 51st Street
New York 19, New York

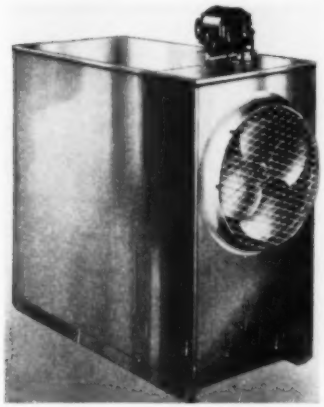
LEADERS IN PETROLEUM CHEMISTRY— MAKERS OF ADDITIVES: ALCOHOLS: NITRILE AND BUTYL RUBBER: CHEMICALS

for any operation involving unusual conditions such as high temperature, high pressure, corrosive or non-conducting liquids." Diagrams of its construction and operation are included in a company bulletin.

In the sketch No. 1 is the steel float; 2, steel pipe; 3, bottom plug; 4, top plug; 5, float stops; 6, sensing coil; 7, coil housing and 8, conduit connection.

For a copy of the bulletin write Department A, Clapp Instrument Company, Webster, Mass., referring to PETROLEUM REFINER item **178.**

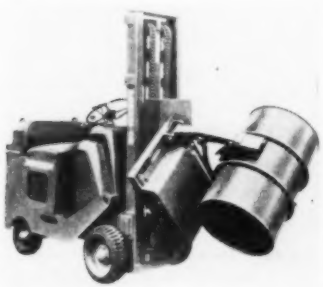
Aquatower



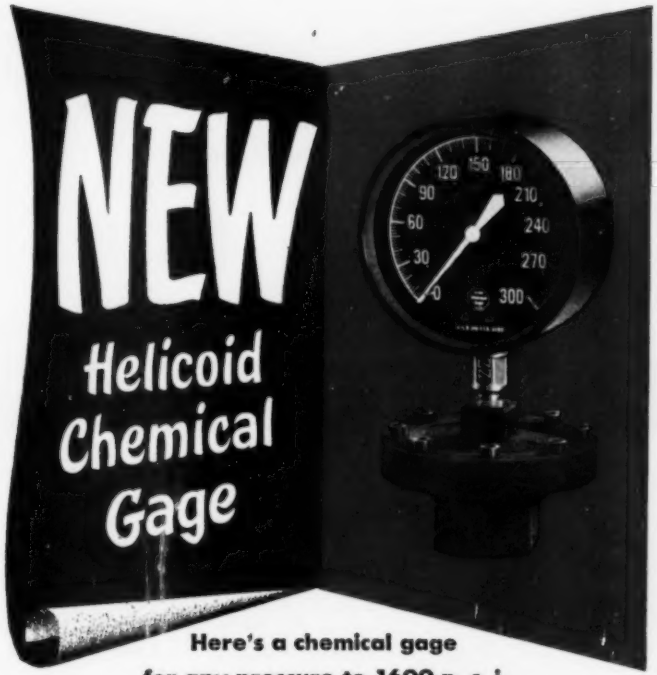
An aquatower in the 7½ ton bracket has been added to the Aquatower line by The Marley Company, Inc., manufacturers of water cooling equipment. Features claimed for this model include compactness, quiet operation indoors or out, all-steel construction, bearing housing with grease-packed ball bearings, nail-less removable redwood filling and other advancements in cooling tower design.

For a copy of Bulletin AQ-49 write The Marley Company, Inc., 3001 Fairfax Road, Kansas City, Kan., referring to PETROLEUM REFINER item **179.**

Barrel Grab



The new revolving barrel grab of Towmotor Corporation is designed to lift and transport open-end drums. It empties the drums by turning them up-side-down. Constant load pressure is maintained throughout the 360 degree revolution "by means of a hydraulic line running through the spindle of the carriage operating the arms of

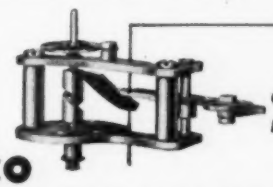


Here's a chemical gage for any pressure to 1600 p. s. i. and also for vacuum or compound ranges, and temperatures to 300° F.

● An accurate pressure gage for use where chemicals or viscous liquids either corrode or clog a Bourdon tube.

The diaphragm is "TEFLON" which resists practically all corrosive chemicals. The diaphragm chamber is supplied of any metal most suitable for the service.

Write for complete information about the new Helicoid Chemical Gage.



Only Helicoid Pressure Gages have the Helicoid Movement

ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE
Bridgeport 2, Connecticut

TRADE MARK

the grab." Drums having a capacity up to 2100 pounds and with diameters from 15 to 30 inches can be handled by the barrel grab.

For further information write Towmotor Corporation, 1226 East 152nd Street, Cleveland 10, Ohio, referring to PETROLEUM REFINER item **180.**

Chrome-Nickel Stainless Steel

A new "Handbook for the Fabricator," covering chrome-nickel stainless steel sheets and plates, has been released by Eastern Stainless Steel Corporation. Illustrated with varied applications of sheets and plates, the handbook features description, analysis and other data on chromium-nickel steels. Other sections show operations of fabrication and "recommended grades" for various applications, a corrosion data guide, and chemical composition and physical contents data.

For a copy of the handbook write on company letterhead to Eastern Stainless Steel Corporation, Baltimore 3, Md., referring to PETROLEUM REFINER item. **181.**

Flow Meters

Steps in the making of Hays-Cochrane electric and mechanical flow meters are described in Bulletin 800 of Penn Industrial Instrument Corporation. These meters are now being marketed as Hays-Penn meters through The Hays Corporation.

For a copy write Penn Industrial Instrument Corporation, 3116 North Seventeenth Street, Philadelphia 32, referring to PETROLEUM REFINER item **182.**

REFINERY EQUIPMENT

LEADER BUILDS
TANKS — KETTLES — FRACTIONATING COLUMNS
HEAT EXCHANGERS and SPECIAL EQUIPMENT
OF
STEEL—STAINLESS STEEL—NICKEL—MONEL
INCONEL—COPPER—EVERDUR—HERCULOY
HASTELLOY — ALUMINUM and CLAD STEELS

LEADER IRON WORKS, INC.
2170 N. JASPER DECATUR, ILLINOIS

Corrosion Inhibitor Rods

Cor-In corrosion inhibitor zinc rods, manufactured by Roto Metals, Inc., are fitted with standard pipe-plug ends, which screw into heat exchangers, piping and other hydraulic equipment to protect against corrosion. The zinc rods come in ⅜, ½, ⅝, ¾ and 1-inch diameters, and up to 12 inches in length. The rods "extend the protection of galvanizing," can be renewed readily and have "higher electro-chemical potential than the metals to be protected from corrosion." Oxygen or other corrosive causations consume the zinc in preference to the electro-chemically less active metals, it is explained.

For further information write Rotometals, Inc., 980 Harrison Street, San Francisco 7, referring to PETROLEUM REFINER item **183.**

Drum Cradle Truck

Mixing and agitating of liquids, powders and other compounds in one gallon round cans up to 55 gallon drums is claimed with the portable, motorized drum cradle truck of Morse Manufacturing Company, Inc. The 1½-hp. enclosed type motor, an integral part of the cradle truck, rotates a full drum load at 10, 20 or 40 rpm. Swivel casters help "prevent slippage of the truck in loading and make steering easy." Idler rollers in various lengths with adjustable collars make it easy to rotate. Rubber shock mounts "throw the weight of the rotating container against the drive wheels and absorb excess vibration." A safety catch on the angle nosepiece catches under the drum to be loaded and holds it steady while the truck is being rolled over to operating position.

For further information write Morse Manufacturing Company, 122 Dickerson, Syracuse, N. Y., referring to PETROLEUM REFINER item **184.**

Welding Helmet

The new combination skullgard-welding helmet is described in Bulletin CO-2 issued by Mine Safety Appliance Company. Featuring an "instant release" attachment which permits the welding shield to be removed quickly from the cap-type skullgard, the helmet combines "protection and wearer-comfort with outstanding convenience features." The helmet is joined to the skullgard by means of posts fitted

OIC VALVES
are installed at
ESSO
BAYWAY PLANT
Esso Standard Oil Co.
Plant, Linden, N. J.

Another Installation where

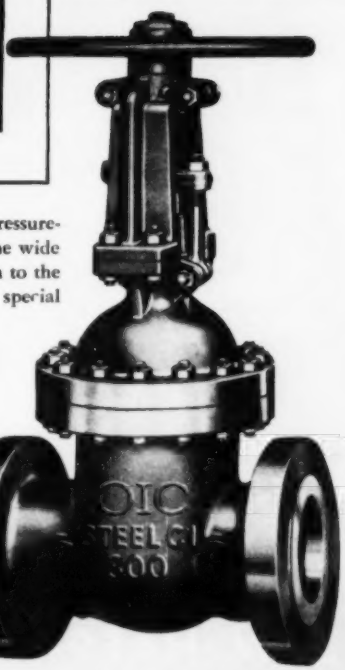
OIC
SETS THE PACE IN VALVES

THERE'S a growing demand for OIC Valves in the petroleum field. The job of directing and controlling America's most precious fluids demands valves that function with absolute precision and safety for long periods of time.

Recognizing this, OIC selects materials, both for trim and for pressure-containing parts, with the utmost consideration for their utility over the wide range of applications for which the valves are recommended. In addition to the standard trim materials, special trims and combinations of trims for special application are available.

Advanced design features make OIC Valves *pace-setters* of the field!

See Your OIC Distributor for Prompt, Efficient Service



GET YOUR FREE COPY OF THE FAMOUS OIC CROSS REFERENCE CHART!

Eliminate your valve replacement problems with the OIC Cross Reference Chart. Simply check the number of the valve on the line, turn to the chart, and find the correct OIC Valve to replace it. Send your request to *The Ohio Injector Company, Wadsworth, Ohio.*

OIC
VALVES
STEEL • IRON • BRONZE

0-249-16

with spring catches which are inserted into plastic lugs at either side of the skullgard. Light pressure at the forward end of the posts retracts the spring catches and releases the helmet.

For a copy of the bulletin write Mine Safety Appliances Company, Braddock, Thomas and Meade Streets, Pittsburgh 8, referring to PETROLEUM REFINER item **185.**

Process Equipment

Industrial Process Engineers has published a new catalog which describes examples of the "Standard-Plus" complete process units, complete process plants and special process equipment offered by the company. Included are absorbers, agitators of all kinds, autoclaves, blenders, condensers, crutchers, crystallizers, digesters, dissolvers, drives, driers, extruders, heat exchangers, kettles, mixers, reactors, stills and valves.

For a copy of the catalog write Industrial Process Engineers, 8 Lister Avenue, Newark, N. J., referring to PETROLEUM REFINER item **186.**

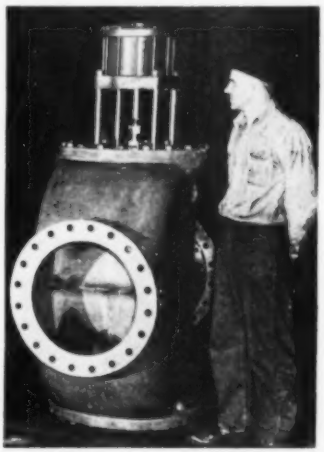
Retainer Services

Foster D. Snell, Inc., has available a bulletin which outlines forms of service on a retainer basis. Retainer groups include junior advisory, research and fellowship. Details of each group are given.

For a copy of the bulletin write Foster D. Snell, Inc., 29 West 15th Street, New York 11, referring to PETROLEUM REFINER item **187.**

Double Ported Valves

Kieley & Mueller, Inc., claims that its 20-inch double ported valve is the largest valve ever to be made with composition disc construction for tight shut-off service. About seven feet high, each valve weighs 7000 pounds. Operated by air cylinders, the valves incorporate the same basic body design and construc-



tion characteristics of the company's automatic control valves. The complete range is now ½ to 20 inches, with all sizes being made for either open-and-shut or throttling control. Pressure drop is held to a minimum "because the valves are designed with extremely large flow passages assuring that all pressure drop occurs through the seats."

For further information write Kieley & Mueller, Inc., North Bergen, N. J., referring to PETROLEUM REFINER item **188.**

Insulated Piping

Two booklets published by The Ric-wiL Company discuss problems involved in insulated piping distribution systems. "Engineering Data for Underground Steam Distribution, Section 480-2" deals with the layout of the route, methods of estimating steam loads, steam flow charts and tables, properties of steel pipe, properties of saturated steam and other similar related topics. "Typical Engineering Drawings — Section 480-3" reproduces actual drawings used in a wide variety of insulated piping installations. These include industrial, educational, housing, hospital, public utilities, railroad and governmental projects.

For a copy of the booklets write The Ric-wiL Company, Union Commerce Building, Cleveland, Ohio, referring to PETROLEUM REFINER item **189.**

Magnetic Starters

Designed for starting and protecting motors up to 50 hp., General Electric Company's new line of a.c. magnetic starters are available in Nema sizes from 0 through 3. A plastic-encased coil enclosure protects the windings against dirt, moisture or damage during installation. Self-lubricated vertical slots in the sides of the enclosure permit the magnet armature guides to move smoothly. The silver contacts are easy to inspect, interchange and remove and their large surfaces spread any wear

A safe ladder guard made of

WHEELING EXPANDED METAL

Wheeling

"Material of a thousand uses"

YOU'RE looking from the ground up at only one of the thousands of interesting uses of Wheeling Expanded Metal.

Perfect for ladder, window, machine and skylight guards. Also as a partition, "ExM" admits light and air yet prevents intrusion. Wonderful for teller cages, grilles, storage racks, industrial trays and baskets.

Heavy types make non-slip stair treads and catwalks, for "ExM" comes in a wide variety of weights and mesh sizes . . . also painted and coated.

You should have complete information about it on file. Write:

WHEELING CORRUGATING COMPANY

WHEELING, WEST VIRGINIA

ATLANTA · BOSTON · BUFFALO · CHICAGO · CLEVELAND · COLUMBUS · DETROIT · KANSAS CITY
LOUISVILLE · MINNEAPOLIS · NEW ORLEANS · NEW YORK · PHILADELPHIA · PITTSBURGH · RICHMOND · ST. LOUIS

Yours FOR THE ASKING... write now!

This 32-page book alphabetically lists all chemicals available through Harshaw, relates the history of the Company and describes Harshaw's major activities. Write for a copy.

THE HARSHAW CHEMICAL CO.
1945 East 97th Street, Cleveland 6, Ohio
BRANCHES IN PRINCIPAL CITIES

over a broad area. An arc shield of cold-molded asbestos prevents arc-over between contacts. The silicon steel magnet has a permanent air gap in a non-wearing surface to insure quick drop-out.

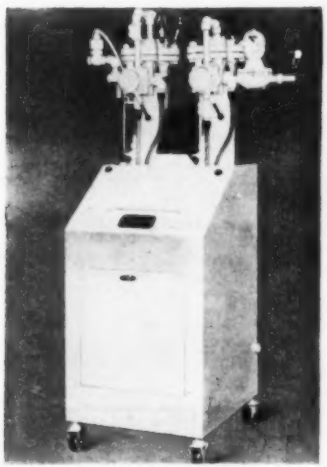
For a copy of Bulletins GEA-5153 and GEA-5154 write General Electric Company, Schenectady 5, N. Y., referring to PETROLEUM REFINER item **190.**

Steam Separators

In order to facilitate selection of a steam separator for a given set of conditions, Wright-Austin Company has published a chart that enables one to quickly select the most efficient size and type of steam separator. A part of the chart is a method for determining the pressure drop on an oil separator for an exhaust steam line. Scales given include saturated steam flow in thousands of pounds per hour, superheat scale in degrees Fahrenheit, pressure drop scale for live steam separators and another pressure drop scale for exhaust steam. Also included are two tables which give the steam flow through various types separators at different pressures.

For a copy of the chart write Wright-Austin Company, 315 West Woodbridge Street, Detroit 26, Mich., referring to PETROLEUM REFINER item **191.**

Package Demineralizing Unit



Model "200," a new package demineralizing unit developed by Belco Industrial Equipment Division, Inc., has a maximum flow rate of 60 gallons per hour and an exchange capacity of 14,000 grains as $CaCO_3$. A self contained unit with the regenerant containers concealed in the cabinet, the tanks are rubber lined and piped with Saran piping and tubing. Steel constructed with ball bearing casters, the unit comes ready to be connected to the raw water line. Electronic controls "assure automatic shut-off when a predetermined degree of impurity in the demineralized water is reached.

For a copy of Bulletin 54 write Belco Industrial Equipment Division, Inc., 102 Iowa Avenue, Paterson 3, N. J., referring to PETROLEUM REFINER item **192.**

Automatic Locking Unit

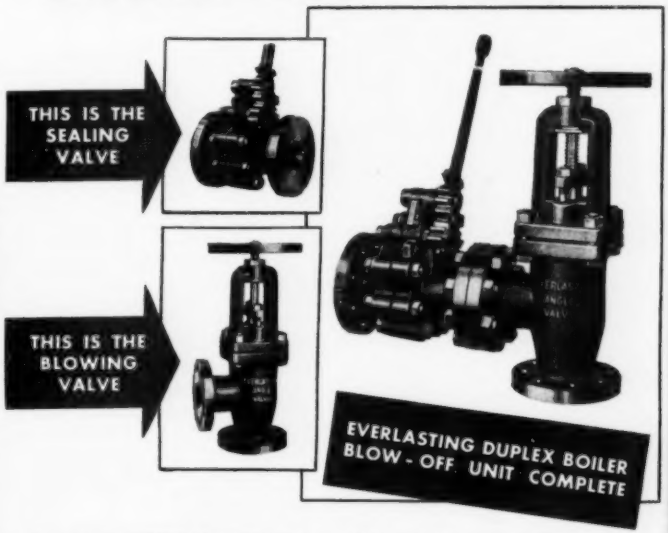
The new line of Midget Ever-Lok automatic locking plugs, receptacles and cord connectors, announced by Russell and Stoll Company, Inc., features the automatic locking Ever-Lok construction, and is adaptable for all types of portable electrical equipment. The manufacturer claims: receptacle has fully protective hinged cover and gasket, strong spring keeps door closed and dust-tight, solderless terminals with metal shield for protecting terminals and compact design yet large capacity. Plugs automatically lock in receptacles or connectors.

For a copy of Catalog EL49-50, write Russell and Stoll Company, Inc., 125 Barclay Street, New York 7, referring to PETROLEUM REFINER item **193.**

Thermocouples

Information on selection of proper thermocouples and protecting tubes, methods of checking thermocouples and pyrometers and installation is given in Wheelco Instruments Company's Bulletin T/C 7. Descriptions and lists of cur-

CO-ORDINATED FOR BLOW-OFF SAFETY



A "regular" EVERLASTING Valve that opens fully with one short movement of the lever . . . a wheel-operated EVERLASTING Companion Angle Valve built to take the punishment of the blow-off . . . these two valves, coupled together, provide a combination that meets full code requirements for dual valve blow-off.

The lever-operated EVERLASTING Valve, designed for unimpeded, straight-through flow, maintains its tight seal, because it re-grinds itself with each operation. It cannot wedge or stick.

The EVERLASTING Companion Angle Valve, designed specifically for blow-off service, stoutly resists blow-off water and the abrasive action of solids in such water.

Either valve obtainable separately if desired. Write for descriptive bulletin.

EVERLASTING VALVE CO., 49 Fisk St., Jersey City 5, N. J.

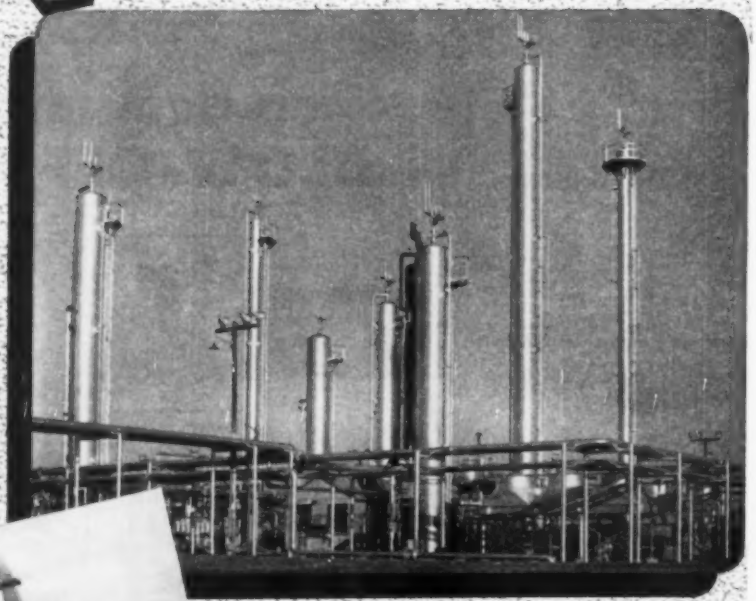
Everlasting Valves

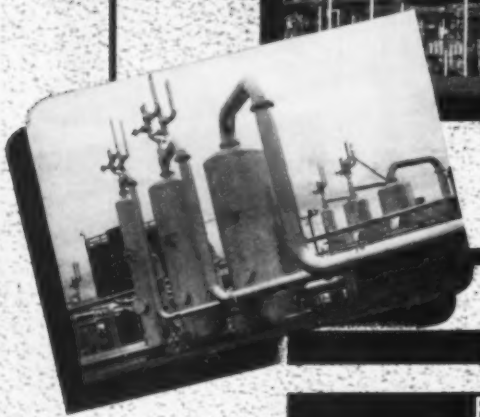
Trade-Mark "EVERLASTING" REG. U.S. PAT. OFF.

for everlasting protection

TULSA TYPE

BUILT *Right*





ABSORBERS
REABSORBER
SCRUBBERS
STRIPPERS

FRACTIONATING COLUMNS
REACTIVATOR
STILLS
STRUCTURAL STEEL
VARIOUS PRESSURE VESSELS

FLINT STEEL CORPORATION

TULSA, OKLAHOMA

rent prices on thermocouples, thermocouple wire, lead wire, heads connectors, plug and socket assemblies, insulators, protecting tubes and radiation heads are also given. Temperature, millivolt curves, resistance tables, pipe and wire sizes and lead wire conduit capacity are furnished in chart form.

For a copy write Wheelco Instruments Company, 847 W. Harrison Street, Chicago 7, referring to PETROLEUM REFINER item **194.**

Reflectogage

The Sperry reflectogage, a portable, ultrasonic instrument for measuring thickness of materials from one side only, is described in a new Sperry Products, Inc., publication, Bulletin 3700. The theory and general application of the instrument to non-destructive measurements of formed parts and assemblies of various metals and plastics up to four inches in thickness is featured as well as the interpretation of the visual ultrasonic indications. Other uses of the reflectogage include tests for the lack of bond, lamination and internal defects in sheet stock.

For further information write Sperry Products, Inc., Danbury, Conn., referring to PETROLEUM REFINER item **195.**

Refractometer

Production of a new refractometer for testing and controlling the quality of chemicals, foods and oils has been started by Bausch & Lomb Optical Company. The portable, electrically illuminated instrument affords "accurate refractive index readings." Its detachable prism system may be removed by the user and replaced with a duplicate set, should repairs become necessary. Other features include a built-in, corrosion-free glass scale, a dust-proof housing and illumination system and stationary eyepieces.

For further information write Bausch & Lomb Optical Company, 635 St. Paul Street, Rochester 2, N. Y., referring to PETROLEUM REFINER item **196.**

Plastic Aprons, Sleeves

New Chemgard translucent plastic aprons and sleeves for protection against chemicals, greases, dirt, and solvents in the processing industries, industrial plants, mills, and shops are described in Bulletin CZ-2, published by Mine Safety Appliances Company.

These aprons and sleeves are "nonporous, non-absorptive, stainproof, odorless, easy to keep clean and will not crack or deteriorate at normal working temperatures. Seams are electronically welded and plastic neck and waist straps are permanently sealed to the garment at one end, fitted with adjustable snap fasteners at the other."

For further information write Mine Safety Appliances Company, Braddock, Thomas and Meade Streets, Pittsburgh 8, referring to PETROLEUM REFINER item **197.**

Welding Electrode

The Arcaloy a.c.-d.c. stainless welding electrode, manufactured by Alloy Rods Company, is claimed to have excellent arc starting qualities on all types of a.c. welding equipment and outstanding welding characteristics on either a.c. or d.c. It also has "a smooth, stable arc with fine-spray weld metal transfer, the slag is easily and completely removed, leaving no secondary film, and the bead is uni-

No More Slipping Accidents!

AW SUPER-DIAMOND FLOOR PLATE

A Better Footing for Product and Plant

Put this floor plate in your plant—or on your product—and say goodbye to costly slipping accidents. Even when the surface is wet or oily, exclusive engineered design with Super-Diamonds at 45° angles gives grip-without-a-slip safety! Easy to match without waste. Easy to clean with mop, broom or hose. Needs no maintenance. Use AW Super-Diamond for safe, strong, clean walkways, loading platforms, fire escapes, trench covers, running boards, machine tool bases—1001 other product and plant applications.

FREE *16-page Catalog L-58 crammed with valuable information. Write now.*

AW SUPER-DIAMOND
FLOOR PLATES THAT GRIP

A Product of **ALAN WOOD STEEL COMPANY**
Conshohocken, Pa.

Other Products: Permaclad, Stainless Clad Steel • AW Super Grip, Abrasive Floor Plate • Billets • Plates • Sheets (alloy and special grades)

form and full-throated with straight-line feathered edges." It is packed in all-steel moisture-proof containers.

For further information write Alloy Rods Company, York, Pa., referring to PETROLEUM REFINER item **198.**

Mercury Vapor Detectors

General Electric Company's instantaneous electronic mercury vapor detector measures concentrations of mercury vapor in the air which may be injurious to the health of workers. It will also give indications of vapors of ozone, illuminating gas, benzene, pyridine, diethylacetal, toluene and others. Operating on the principle that ultraviolet light is scattered when it passes through atmosphere containing mercury vapor, the detector will measure vapor concentrations ranging from 0.03 to 3.0 milligrams per cubic meter, or from 0.004 to 0.37 parts per million by volume. Accuracy is approximately 5 percent.

For a copy of Bulletin GEC-312 describing the detector, write General Electric Company, Schenectady 5, N. Y., referring to PETROLEUM REFINER item **199.**

Synthetic Floor Coating

Specifications and resistance tests for Resn-X, synthetic polymer floor coating manufactured by Rock-Tred Corporation, are featured in a new technical data sheet. How to clean the surface to be coated and cautions when using the coating are listed as are suggestions for general efficiency and application data.

For a copy write Rock-Tred Corporation, 629 West Washington Boulevard, Chicago 6, referring to PETROLEUM REFINER item **200.**

Power Hammer

Hamer - Dril, developed by Dril-Hamer, is an adaptor that converts any ¼-inch electric drill into a power hammer suitable for any purpose where rapid, moderately heavy hammering is required. It may also be operated in drill-press or by flexible shaft, striking "blower-revolution" of the driver used. The hammer is designed for small screw sizes and takes all Rawldril sizes from 5/32 to 5/8 inches. Weighing less than three pounds, the Hamer - Dril has a "built - in" force which is the same whatever the speed or power of the driver.

For further information write Dril-Hamer, P. O. Box 158, Planetarium Station, New York 24, referring to PETROLEUM REFINER item **202.**

Gas Combustion

Bryant Heater Company has available five bulletins covering new gas combustion equipment. Bulletin 6A-4 presents the company's line of combustion blowers. Bulletin 6B-1 describes the line of gas boosters to match the blower line. In Bulletin 1B-1a, blast tips are discussed. Cage blast burners in various assemblies, including mounting cages and blocks are included in Bulletin 2A-1. Blast torch burners, which includes the mixjector, a new mixing device using low pressure air and gas, are described in Bulletin 2C-1.

For a copy of the bulletins write Bryant Heater Company, 1020 London Road, Cleveland 10, Ohio, referring to PETROLEUM REFINER item. **201.**

Low Temperature Insulation

The Johns-Manville insulation for low temperature service is presented in a new company folder. It provides essential data on sizes, temperature limits, conductivity, strength, water, absorption and combustibility. Also included are suggested uses for Zerolite which comes in the form of sheets, lagging and pipe insulation.

For a copy of the folder write Johns-Manville, 22 East 40th Street, New York 16 referring to PETROLEUM REFINER item **203.**

Floor Safety

A new improved Sol-Speedi-Dri, which absorbs floor greases and oils, is announced by Safety & Maintenance Company, Inc., which claims it is "fluffier and has 10 percent greater bulk per pound."

For further information write Safety & Maintenance Company, Inc., 1 Wall Street, New York, referring to PETROLEUM REFINER item **204.**

Concrete Drill Bit

Rotary concrete drill bits, developed by Rotary Concrete Drill Company, range from ¾ to 2 inches in size and are handmade "from high-grade steel with heat treated special carbide cutters set in and brazed to the blunt end of the bit shaft." It is claimed that the blunt end of the bit enables it to drill right through gravel or rounded rocks in concrete as well as reducing breakage to a minimum.

For further information write Rotary Concrete Drill Company, 650 South Arroyo Parkway, Pasadena 2, Calif., referring to PETROLEUM REFINER item **205.**

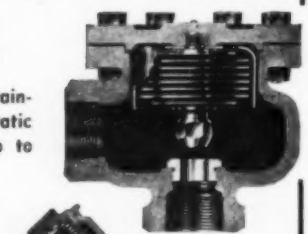
Nicholson Steam Traps Show

PRODUCTION INCREASES UP TO 30%

2 to 6 Times More Drainage Capacity Speeds Circulation

Plant records show that the greater drainage capacity of Nicholson thermostatic steam traps increases production up to 30%.

Other reasons why an increasing number of leading plants are standardizing on Nicholson: operate on lowest temperature differential, 5° to 15°, depending on trap size and steam pressure; record low for steam waste (as low as 1%). 5 types for every purpose; size ¼" to 2"; press. to 225 lbs. BULLETIN 1047.



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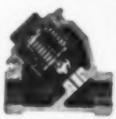

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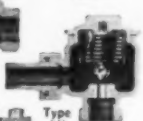

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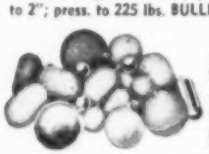
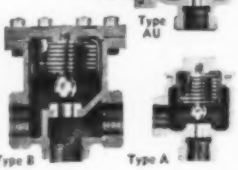


HIGH-PRESSURE FLOATS — Stainless, monel, steel or plated steel. Welded. In all sizes and shapes; for operating mechanisms and as tanks or vessels. 2-day delivery. BULLETIN 348.

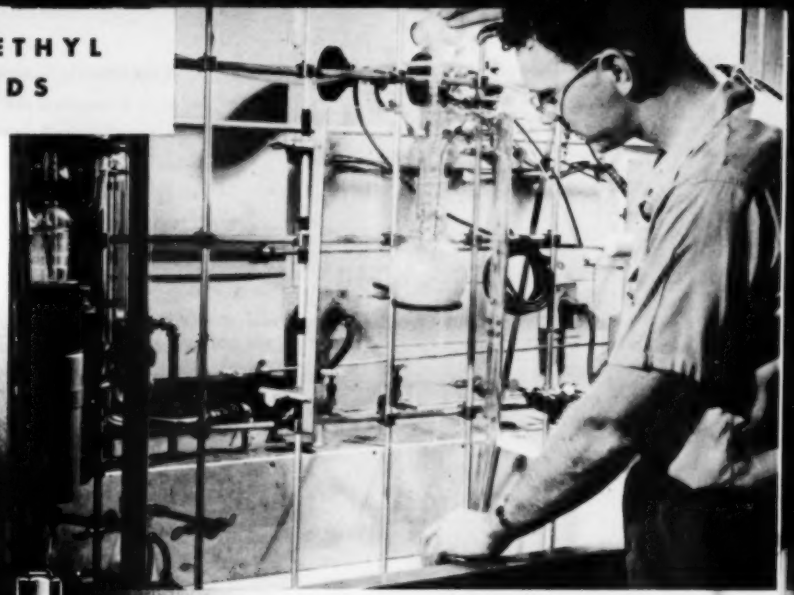


Type B

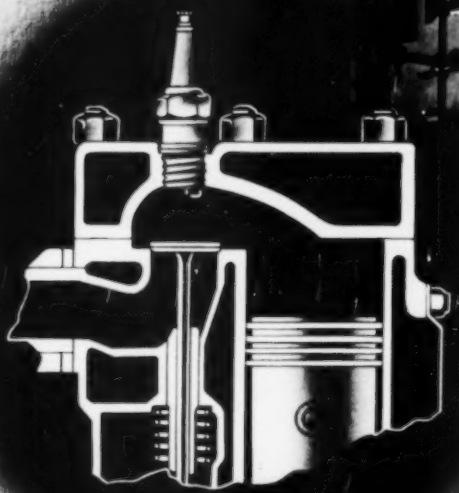
Type A

W. H. NICHOLSON & CO., 207 Oregon St., Wilkes-Barre, Pa.

DUPONT TETRAETHYL
LEAD COMPOUNDS



The chemical laboratory contributes much helpful data on these investigations. Here, rates of sublimation are being measured in connection with combustion chamber deposit studies.



Du Pont Research

At Work on the Problem of Engine Deposits

Engine parts are carefully examined after each test.

Du Pont research on tetraethyl lead and other anti-knock agents is aimed at improving fuel performance and fuel utilization. A vital phase of this research is learning more about how fuels behave inside the combustion chamber. One such basic study is devoted to an investigation of engine deposits.

Although much work has been done on this subject, there is still a great deal to learn about the factors affecting deposit formation, as well as the mechanism by which these deposits affect combustion.

Fuels, lubricants, design, operation—these and other variables which can affect deposits are all being investigated, working toward reduction of deposit formation. This is another example of Du Pont research working on problems of interest to every refiner—research to help you create better fuels, for today and for the future.

DU PONT
REG. U. S. PAT. OFF.

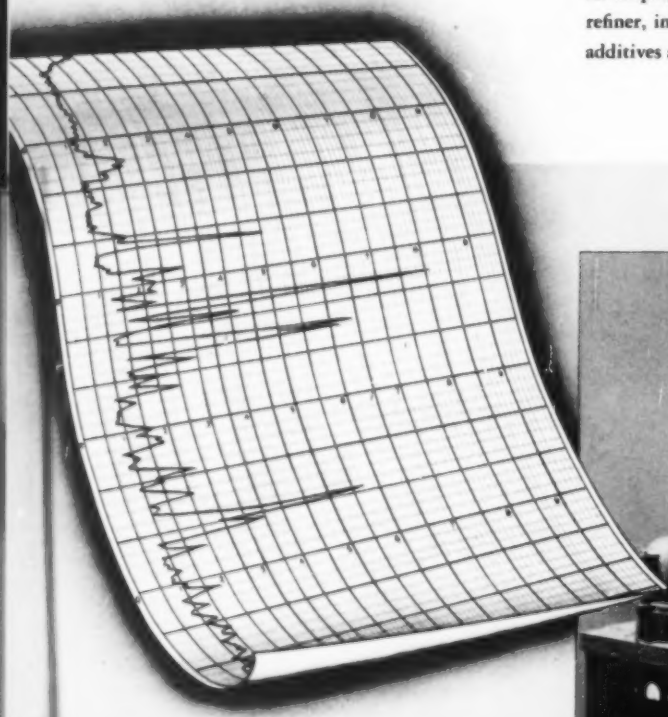
Better Things for Better Living . . . *Through Chemistry*

Research...

To Help Every Refiner

With the trend in engine design toward higher compression ratios, it is essential that the effects of combustion chamber deposits be studied carefully. This problem concerns every refiner because it has an important bearing on meeting and satisfying the motorist's needs.

Du Pont chemists, engineers, and physicists are at work investigating the many variables that can affect deposit formation, as well as the effect of these deposits on engine parts and operation. In this and other research projects, Du Pont is developing information on problems of interest to every refiner, information which will also contribute to improved additives and fuels—today and in the future.



The X-ray spectrometer is used to give quick accurate analyses of engine deposits.

MAKE DU PONT THE SOURCE FOR ALL OF YOUR GASOLINE ADDITIVES . . .

Tetraethyl Lead Compounds
Motor Mix—Aviation Mix
Antioxidants
Metal Deactivator — Dyes

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Better Things for Better Living . . . *Through Chemistry*

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PETROLEUM CHEMICALS DIVISION
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About EQUIPMENT and SERVICE Suppliers

R. G. Caouette Appointed Rockwell Division Manager

Ralph G. Caouette has been appointed general manager of the Pittsburgh Equitable Meter Division of Rockwell Manufacturing Company.

Caouette

He was production superintendent of the Delta Division before coming to Pittsburgh. Later he became manager of industrial engineering for all of Rockwell's plants. Recently he has been general manager of the Red Star Products Division at Norwalk, Ohio.

Before joining Rockwell, Caouette was industrial engineer for Minneapolis-Moline Implement Company. He attended Waynesburg College and George Washington University.

Schaible Expands Program, Personnel for Williams Valve

With the acquisition of D. T. Williams Valve Company, The Schaible Company has announced a program whereby the Williams operations will be expanded in both production and marketing. Administrative, manufacturing and marketing operations will function under divisional direction.

Cara L. Lane will direct the works operations of the Williams plant in addition to being a director of the company. Previously he was works manager of Schaible's parent plant. He also has been associated with The Walworth Corporation and Lunkenheimer Company.

Clifford B. Mueller, general sales manager for Schaible, has been appointed a director of Williams and will direct sales of the Williams' division.

Pittsburgh Steel Appoints

K. H. Bender has been appointed sales manager of tube specialties of the Mid-Continent district of Pittsburgh Steel Company with headquarters in the Tulsa office. He was formerly tube sales engineer at the company's general office in Pittsburgh.

T. R. Miller has been appointed assistant sales manager.

Service Trip Made 4847 Miles

E. E. Childress, chief engineer of Stewart & Stevenson Services, Houston, has set what his company believes to be a record for a service trip. He flew 4847 miles to Bolivia to check Diesel installations sold to companies operating there.

Dow Transfers to Dowell Its Cathodic Protection Products

Sale of cathodic protection products for retarding electrolytic corrosion of pipe lines and industrial equipment has been transferred from the Magnesium Sales Division of The Dow Chemical Company to Dowell Incorporated, a wholly-owned Dow subsidiary. The line includes five sizes and types of cored magnesium anodes, a package unit (Galvopak) in two sizes and Galvoline, a cored magnesium ribbon. Only one type of magnesium anode, a cored rod for use in domestic hot water heaters, is retained by the Dow Magnesium Sales Division.

Guy Williams, assistant sales manager and a member of the Dowell staff for 12 years, heads the new sales activity. Yale Titterington, corrosion and development engineer, will handle technical service aspects.

Clark Names W. H. Barnes To Technical Service Staff

Clark Brothers Company, Inc., Olean, N. Y., has named W. H. Barnes a member of the technical service staff in its Tulsa office.

Barnes

Graduating from the University of Oklahoma with a bachelor of science degree in chemical engineering in 1936 Barnes worked for a year with the U. S. Bureau of Mines in Bartlesville. Then he attended the Massachusetts Institute of Technology, receiving his master of science degree in chemical engineering in 1938. Joining Standard Oil Company (Indiana), he worked for three years in technical service before transferring to Stanolind Oil & Gas Company and specializing in designing and test work on natural gasoline and recycling plants.

Illinois Water Treating Companies "Join Forces"

Elgin Softener Corporation, Elgin, Ill., and Illinois Water Treatment Company, Rockford, Ill., have joined forces, "making available one of the most complete water conditioning and de-mineralization services in this specialized field," according to Chester T. McGill, head of Elgin.

Under the new set-up, each company will maintain its name identity and personnel, but "through consolidating manufacturing operations, production economies can be passed on to the user." An intergration program which will broaden the scope of services available

● Offering wear resistance superior to standard oil based floor enamels, NUKEMITE 40 Protective Coating is also ideal where chemical action is a factor. It is produced in several colors, making it possible to give your plant floor a cleaner, more attractive appearance.

Nukemite 40 is a vinyl copolymer solution that bonds firmly and forms a tough coating when dry. It resists acids, alkalies and petroleum solvents—does not saponify when subjected to cleaning agents—gives long-lasting protection even under severe abrasive conditions. It is odorless, tasteless and non-contaminating; fully tested and proved in a wide range of practical applications.

EASY TO APPLY

Nukemite 40 is easily applied by brush or spray method after preparation of the floor by cleaning and rinsing. Minimum out-of-service time (36 hours) is required for application of primer, application of Nukemite 40, and drying — another NUKEMITE feature.

Specify Application and Order a Trial Kit Today. $3.30 prepaid.

Nukem

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PRODUCTS CORPORATION
104 Colgate Avenue
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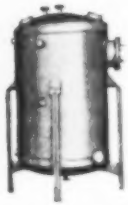
LEAD
LINED EQUIPMENT
. . . curbs Corrosive Acids

The "vessels" used in the process industries may range from a five-gallon receptacle to a cavernous tank. Details of construction may differ. But, when it comes to handling corrosive chemicals, much of this equipment has at least one thing in common . . . a lining of lead. Because *Lead blunts the teeth of hungry acids.*

Leaders in the chemical processing field have something in common, too. They rely on the leader in lead products . . . National Lead . . . for their lead-lined and lead-covered equipment. They know that National offers . . . *and delivers* . . . not merely a mass of metal bearing outward resemblance to drawing and blueprint, but a piece of acid-handling apparatus that has the built-in ability to do the job it was bought to do. Into each unit goes the know-how, from drafting board to shop assembly, that makes the most of lead's resistance to chemical attack plus steel's resistance to physical abuse.



In National Lead's "Homogeneous" lead-lined tanks, drums, agitators, autoclaves and other items of this nature, the lead lining is bonded directly to the steel casing. An inseparable bond is created, a union of lead and steel that obviously will withstand higher temperatures than one in which solder is used.

Every piece of National Lead's "Homogeneous" lead-lined and lead-covered equipment is individually fabricated to your specifications. When you want information on acid-handling apparatus, please consider our specialists in this field *at your service.*

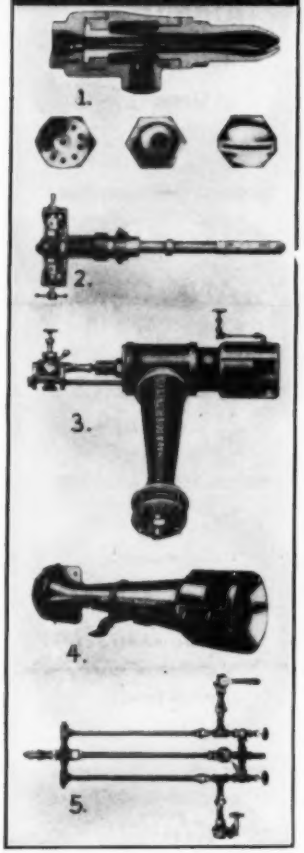
Look to the Leader for Lead

. . . in everything from lead pipe . . . valves . . . sheet . . . and lead-lined or lead-covered equipment . . . to complete acid recovery plants

NATIONAL
Lead Company

New York 6; Baltimore 3; Buffalo 3; Chicago 8; Cincinnati 3; Cleveland 13; Pittsburgh 12; St. Louis 1; Boston 6 (National Lead Company of Mass.); Los Angeles 23 (Morris P. Kirk & Son, Inc.); Philadelphia 25 (John T. Lewis & Bros. Co.); Atlanta (Georgia Lead Works, Div. of Cincinnati Branch); Toronto, Canada (Canada Metal Co. Ltd.).

THE *RIGHT* OIL BURNER OR GAS BURNER *FOR YOUR JOB*



1. **TYPE "S-A"**
(For use where steam is available) *atomizes thoroughly and burns completely*, the lowest and cheapest grades of fuel oil and tar, requiring only low oil pressure and temperatures.

2. **TYPE "S-A-L"**
(Larger capacity burner similar to TYPE "S-A-R") is adaptable in combination with powdered coal burners in large boilers.

3. **COMBINATION GAS AND OIL BURNER**
— the "AIROCOOL" Gas Burner in combination with a TYPE "S-A-R" Oil Burner.

4. **"AIROCOOL" GAS BURNER**
(Of venturi type) assures low turndown without burnback.

5. **TYPE "S-A-D"**
(Refuse Oil Burner) burns acids or caustic oils, sludges, asphalts, tank bottoms, polymer oils, heavy petrolatum, organic oil residuums, waste cutting oils, sulphite pulp liquors, etc.

NATIONAL AIROIL BURNER CO., INC.
Main Office & Factory
1254 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.
Texas Office 2512 South Boulevard, Houston 6

through a nation-wide organization of sales engineers and technical field men with offices in 40 cities.

The Elgin company also has established a Manufacturers' Division to make available its techniques to other manufacturers in the industry. Zeolite is also being made available through Elgin's recent acquisition of Arizona Minerals Corporation, Yuma, Ariz.

W. B. Osgood Partner in Dunbar Engineering Firm

W. B. Osgood has become a partner in Dunbar Engineering Company, New York, representing Edward Valves, Inc., East Chicago, Ind.

Osgood

After graduating from the University of Wisconsin in 1929, Osgood served as sales agent for Globe Steel Tubes Company and later as sales representative for Pittsburgh Steel Company. Since 1938 he has been sales representative, assistant manager of sales, and finally district representative for National Tube Company.

Judd Supply Is Distributor for Tube-Turn Fittings, Flanges

A. B. Judd Supply Company, Houston, has been appointed a distributor of Tube-Turn welding fittings and flanges.

A. B. Judd, president of the recently established company, was president of Republic Supply Company, Houston, until he resigned in 1948 to set up his own organization. He is a member of the Nomads, past president of the Petroleum Equipment Suppliers Association and a director of the Mid-Continent Oil and Gas Association.

Ira Rosin Is Cleveland Agent For Warren Steam Pump Sales

Warren Steam Pump Company, Inc., Warren, Mass., has named Ira Rosin as its Cleveland, Ohio, representative on industrial sales, effective February 1, 1949. His headquarters are at 3751 Prospect Avenue and his territory covers north and central Ohio and Erie, Pa.

Rosin

A chemical engineer who received his education at the University of Cincinnati and Penn State, he has been responsible for the development of the Coil-O-Clave method of heat transfer, Radicon and Radiplex type of resin-making equipment and for the development of Dowtherm equipment.

Girdler Appoints Huber

Harold E. Huber has been appointed head process engineer of the Votator division of The Girdler Corporation, Louisville, Ky.

After attending the University of Kentucky where he received a bachelor of

CONTROL
SCALE AND CORROSION
in
Cooling Towers Compressors and Engine Jackets

Recently developed applications of the newer colloids and surface-active agents in Wright Chemicals for the petroleum industry result in *improved* water conditioning—*positive* scale and corrosion control. Wright Chemicals contain 100% soluble, available chemicals—no waste or inert matter—insuring increased operating efficiency and reduced cost.

Wright improved chemicals are the result of intensive study and research by men with years of experience in the development, production, application and control of water-conditioning chemicals.

Wright has no one cure-all to solve all problems. Each receives individual treatment. The Wright field engineer, who will call on you upon request, will obtain all necessary information and samples for examination in the modern Wright laboratory. Analyses are interpreted in view of supplemental information received, and recommendations made in the form of a proposal. Clients are provided with regular laboratory service as a periodic check upon conditions.

There is a Wright Field Engineer near you, anxious to help solve your scale and corrosion problems. No obligation.

Send for new Bulletin giving full information on Wright chemicals and their applications.

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Specializing in Water Conditioning
GENERAL OFFICE AND LABORATORIES
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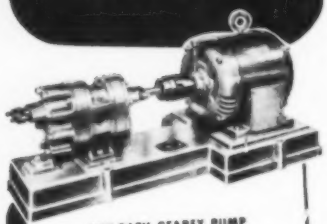
Offices in Principal Cities

SIER-BATH ROTARY PUMPS *have no time for down-time*



SIER-BATH GEAREX PUMP

Balanced axial thrust . . . pulseless flow . . . vibrationless operation . . . roller bushings for precision running under load.

Pumps: oils, varnishes, solvents, molasses, chemical solutions.

Capacities: 1-550 g.p.m.

Discharge: 250 psi for medium or high viscosities. 50 psi for water.

For higher pressures and capacities use SIER-BATH SCREW PUMPS.

A notable feature of Sier-Bath Rotary Pumps is their relative freedom from down-time for repairs and maintenance. Built in a shop equipped for manufacture of the finest precision gears, Sier-Bath Pumps show surprising ability to stand up under the most rugged operating conditions. The value of such sturdy construction cannot be over-emphasized in these days of high operating costs.

ALSO MAKERS OF SIER-BATH PRECISION GEARS

FOUNDED 1905 MEMBER A.G.M.A.

Sier-Bath GEAR and PUMP CO., Inc.

9249 HUDSON BLVD., NORTH BERGEN, N. J.

science degree in industrial chemistry and a master of science degree in organic chemistry, Huber joined Standard Oil Company (Indiana) in 1938. He engaged in exploratory research and pilot plant work until 1943, when he came to Girdler.

He is a member of Sigma Xi and the American Institute of Food Technologists.

Smith Sets Up New Section With Thompson As Supervisor

A shop with complete production facilities for the manufacture of heat transfer equipment has been established by the vessel division of A. O. Smith Corporation. P. A. Thompson has been appointed product supervisor for heat transfer equipment.

Thompson

In the heat transfer and petroleum processing industries for 25 years, he comes to A. O. Smith after 18 years with the Alco products division of American Locomotive Company. Among his positions with the company were New York district manager, assistant manager of commercial development and manager of oil industry sales.

James Gow Is Electric Steel's New Metallurgical Chief

James T. Gow has joined Electric Steel Foundry Company, Portland, Ore., as chief metallurgist and will have charge of all phases of the metallurgical department.

Gow

For the past 13 years he has been associated with the Battelle Memorial Institute where he became supervising metallurgist in industrial metallurgical research. In addition he is author of several technical publications on physical metallurgy. Gow holds patents on metallurgical processes and steel alloys. He is a graduate of the University of Minnesota in the School of Mines and Metallurgy.

Yarnall Makes Changes

Yarnall-Waring Company, Philadelphia, announces changes in its sales and manufacturing divisions as follows:

Joseph Kildare, sales manager, named vice president in charge of sales and Frank W. Miller, works manager, named vice president in charge of manufacturing.

Carl Liberg, formerly with the company's New York sales office, now located at the new district office in Buffalo, N. Y. C. V. Peterson named sales representative in the Cleveland district.

Kerotest Appoints Manager

Stanley S. Willis has been appointed Chicago district manager of the brass

AMMONIA (Refrigeration Grade)

TANK CARS and CYLINDERS

direct service from producing point to user available on contract shipments or spot orders from...

SPENCER

SPENCER CHEMICAL COMPANY

Executive and Sales Offices
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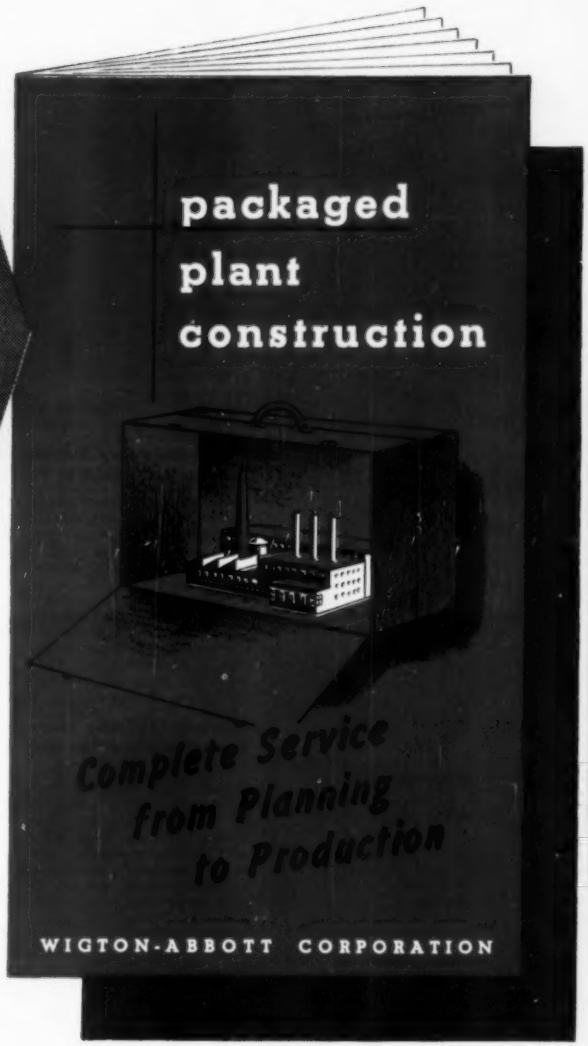
considering **plant construction?**

you should have this booklet...

Yours for the Asking:

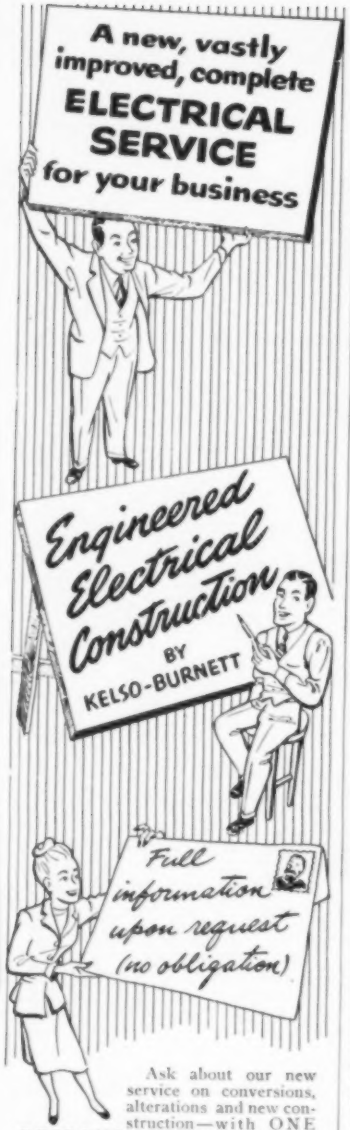


"Packaged Plant Construction" . . . a complete service from planning to production. Whether the problem involves construction of facilities designed from pilot plant data, the development of new processes from flow sheets, or the expansion of present plant facilities, WIGTON-ABBOTT CORPORATION "Packaged Plant Construction" offers the most economical and efficient solution in the shortest time.

A Wigton-Abbott Corporation representative will be glad to consult with you on problems involving any phase of plant design and construction.

Wigton-Abbott Corporation

DESIGNERS · · · ENGINEERS · · · CONTRACTORS **PLAINFIELD, NEW JERSEY**



Ask about our new service on conversions, alterations and new construction—with ONE RESPONSIBILITY, ONE RELIABLE FIRM—from design through installation and construction. Complete staff of electrical engineers and specialists. We work with your engineering firm, general contractor or direct.

KELSO-BURNETT ELECTRIC COMPANY

223 WEST JACKSON BLVD.

K·B SERVING INDUSTRY SINCE 1908

CHICAGO 6, ILLINOIS

division of Kerotest Manufacturing Company with headquarters at 568 West Randolph Street, Chicago. He will service Indiana, Illinois, Wisconsin, Minnesota, North and South Dakota and Montana. Connected with Kerotest since 1931, Willis has been production planning manager over all operation for the past 10 years.

J. L. Young Promoted to Wolverine Sales Manager

J. L. Young, Jr., sales representative for Wolverine Tube division, Detroit, with headquarters in Houston, has been promoted to manager of southwestern sales.

Young

He will headquarter in the company's Houston office and will have charge of Wolverine sales throughout Texas, Arkansas, Louisiana and Oklahoma, as well as supervising the operation of the company's mill depot at 1515 Fulton Street, Houston.

Vapor Recovery Establishes Company Affiliate in Paris

Vapor Recovery Systems Company, Compton, Calif., has established a manufacturing affiliate, Compagnie Technique des Petroles, with headquarters at 124 Boulevard Haussman, Paris, France.

Zarry Toula, managing director, has worked for 25 years in the actual construction and operation of oil refineries and chemical plants throughout Europe. Emeric Kroch, chemical engineer, has been general European agent for Vapor Recovery for 14 years.

Sherwin-Williams Names Sales Representative for Gulf Coast

Walter J. Boll has been named Gulf States Zone representative for sales to the transportation and petroleum trade by The Sherwin-Williams Company. Filling the vacancy caused by the death of E. Langley Rumph, Boll will make his headquarters at Houston.

Starting with the company in 1924 as a stock boy in Cleveland, Boll was soon transferred to the maintenance sales department and later worked in the industrial sales department. In 1941 he moved to the transportation department's zone headquarters in Cleveland. Until his recent appointment he has been Pittsburgh area representative for transportation sales.

Kieley and Mueller Announce Three Personnel Appointments

Kieley and Mueller, Inc., North Bergen, N. J., have announced personnel appointments as follows:

Robert J. Donnelly named general sales manager. During his 10 years with the company, Donnelly has specialized in marketing.

Ward K. Stallings named chief engineer. A graduate of Purdue University, he has been in the company's production, engineering and sales departments since joining the staff 11 years ago.

A. W. Bailey promoted to general

HARPER

NON-FERROUS AND STAINLESS STEEL Everlasting Fastenings OFFER

13 Reasons

FOR USE IN YOUR PRODUCT over common steel...

1 Resistance to Rust and Corrosion
2 Resistance to High Temperatures
3 Non-Magnetic
4 Non-Sparking
5 Re-Usable
6 Attractive Appearance
7 Easy to Clean
8 High Strength
9 Long Life
10 Lower Ultimate Cost
11 Resistance to Fatigue
12 Easy to Plate or Finish
13 Resistance to Abrasion and Wear

OVER 6000 ITEMS IN STOCK

Bolts, Nuts, Screws, Washers, Rivets and Accessories in Brass, Bronzes, Copper, Monel and Stainless Steels.

Write for Catalog giving blue print drawings, dimensions, threads, heads and sizes of each item.

THE H. M. HARPER COMPANY
General Offices and Plant
Morton Grove, Illinois
(Suburb of Chicago)
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200 Hudson Street, New York 13

Branch Offices: Atlanta, Cambridge, Cincinnati, Cleveland, Dallas, Denver, Detroit, Grand Rapids, Los Angeles, Milwaukee, Philadelphia, Pittsburgh, St. Louis, San Francisco, Seattle, Toronto (Canada).

HARPER

office manager. Before coming to Kieley and Mueller in 1948, he was associated with Fisher Governor Company.

General Filter Company Joins Layne Organization

General Filter Company, Ames, Iowa, has joined Layne and Bowler, Inc., Memphis, Tenn., and its affiliated well water supply companies. Layne now offers complete engineered ground water supply service.

J. P. Lawlor, founder of General Filter in 1935, will remain as president. The new board of directors is Lee Rogers, Layne-Minnesota Company; S. L. Olson, Layne-Texas Company; A. W. Ross, Layne-New York Company; M. H. Anderson, General Filter; T. M. Ragsdale, Layne-Central Company; A. G. Schreiber, General Filter; and Lawlor.

Wilson Buys Dudgeon Division

Thomas C. Wilson, Inc., Long Island City, N. Y., has purchased the tube expander business of Richard Dudgeon, Inc., New York City. The purchase expands Wilson's line of equipment to handle both rolling and cleaning of all types of tubing in heat transfer apparatus.

Republic Meters Names Kenzel

Republic Flow Meters Company, Chicago, has appointed Kenneth K. Kenzel manager of its district office located at 3197 Linwood Avenue, Cleveland 8.

An engineering graduate of Northwestern Technological Institute, he has come to Cincinnati after serving as a contracting and application engineer with Republic. Prior to joining Republic,

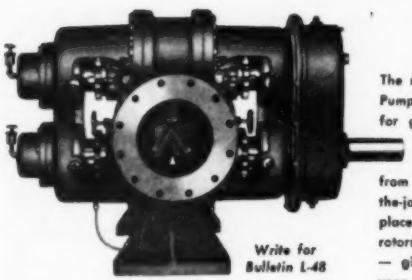
Airetool Sets Record

Thor Thornson, sales manager for Airetool Company, 316 South Center Street, Springfield, Ohio, inspects a G-800 Airetool expander with Robert B. Gordon, Airetool vice president and shop superintendent. The tube expander is believed to have established a record recently in an Eastern oil refinery. More than 18,000 tube ends, each ¾-inch outside diameter by 14 gauge were rolled into a 1½-inch tube sheet. Steel and brass tubes were rolled in equal numbers at 750 rpm. It was not necessary to replace rolls or mandrel and expander rolls were not damaged.

KINNEY

HELIQUAD

LIQUID PUMPS



Write for Bulletin L-48

The record shows Kinney Heliquad Rotary Pumps, with outboard bearings, can't be beat for general petroleum service. The same Heliquad Pump can be arranged to handle liquids ranging all the way from aviation gasoline to crude oil. On-the-job reports prove these positive displacement pumps — with unique helical rotors driven by hardened steel timing gears — give uninterrupted service, year after year. Many Kinney Heliquads are still delivering full rated capacity after twenty years or more on tough pumping jobs. Available plain or steam jacketed, in capacities to 3000 bbls. per hr.

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WE ALSO MANUFACTURE VACUUM PUMPS, CLUTCHES AND BITUMINOUS DISTRIBUTORS

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APPLIES LABORATORY ACCURACY TO PRODUCTION

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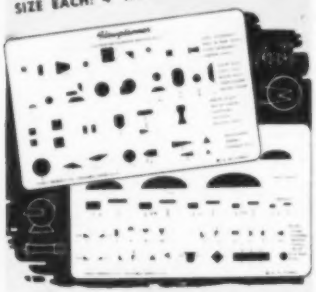
Send for these easy to use
FLOWPLAN TEMPLATES
SIZE EACH: 4" X 7"



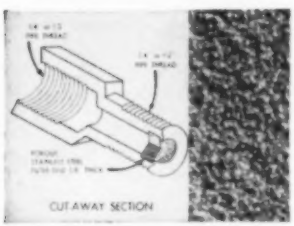
Draftsman Quality symbols for field reports and design! FLOW-PLANNER SET consists of 2 transparent templates—81 precise cut-outs for all standard symbols: instruments, valves, pumps, exchangers, vesselheads, nozzles, process flags, etc. Instruction manual included.

$3.85 Per Set Postpaid

*A prize winning, CE designed set. Hundreds in use in Major refineries, colleges, and chemical plants.

TIMELY Products
Box 2062 Columbus 9, Ohio

New and Exclusive!



Equipoise POROUS Stainless Steel
PRESSURE SNUBBERS

These new snubbers utilize a porous stainless steel disk as the primary element to eliminate pulsations. They can be used to protect all types of pressure sensitive instruments. Namely, pressure gauges; pressure indicating and recording controllers; diaphragm type differential meters; U-tube manometers; differential flow meters; pump governors; and diaphragm regulators. They also can be used as filters or as flow meters on small flows.
The porous disk is made in several standard Grades. Special grades made to suit application.
Grade "G" Air, gases, Butane, gasoline
Grade "E" Water, kerosene, light oils, etc.
Grade "D" Oil, etc., having viscosity over 300 SSU.

Write for literature — Dept. WL

EQUIPOISE CONTROLS
INCORPORATED
100 STEVENS AVE., MT. VERNON, N. Y.

Kenzel was associated with Universal Oil Products Company as an engineer.

Kemp Board Elects Three New Executives and a Director

J. Clarence Kimpel has been elected president and chairman of the board of directors of C. M. Kemp Manufacturing Company, Baltimore, succeeding the late Wallace W. Kemp. Kimpel was formerly secretary and treasurer.

Edward J. Funk, Jr., elected vice president, will continue as chief engineer. Elected secretary and treasurer to succeed Kimpel, Charles E. Wilbur was formerly assistant secretary and treasurer. Wilfred G. Keir was added to the board of directors.

Precision Opens Branch; Walter A. Blair Is Manager

Precision Scientific Company, Chicago, has opened a branch office at 302 Hobart Building, 582 Market Street, San Francisco 4, with Walter A. Blair in charge.

Blair studied chemical engineering at the University of Wisconsin and worked in design and layout of process control systems before being commissioned a lieutenant in the Navy. After the war, he was a product design engineer with Fansteel Metallurgical Corporation, North Chicago.

Oliver Appoints T. C. Reeves

Oliver United Filters, Inc., has appointed Thomas C. Reeves to its eastern sales division staff. A graduate of Syracuse University with bachelor of science and chemical engineering degrees, he formerly was chief engineer of Sherwin-Williams Company at the company's Bound Brook, N. J., plant.

Brooks Rotameter Names Agent

John G. Kirkpatrick has been appointed exclusive representative in the Pittsburgh area for Brooks Rotameter Company. His territory includes western Pennsylvania and West Virginia. He has been instrument engineer for Koppers Company for the past seven years.

Atlantic Names L. H. Butcher

The Atlantic Refining Company has appointed L. H. Butcher its exclusive West Coast sales representative for packaged chemicals. The major items involved include the Ultrawets, a series of alkyl aryl sulfonates.

R-S Products Appoints Agent

R-S Products Corporation, Philadelphia, has appointed Trident Engineering Company, San Francisco, as representative of its valve division.

STEEL DRUM
RECONDITIONING
MACHINERY
IN WORLDWIDE USE
REDUCES DRUM COST
SEND FOR LITERATURE
L. M. GILBERT CO.
DREXEL BLDG., PHILADELPHIA, PA.

QUICK REPAIRS ON CONDENSERS and HEAT EXCHANGERS

If you need condenser or heat exchanger repairs *in a hurry* call us. We specialize in fast, high quality work.

25 Years Successful Experience

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"Service, Not Promises"
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916 S. PETERS STREET NEW ORLEANS, LA.

Paddock Sales of Texas

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... IS ITS BATTERY OF HEATERS
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FOR SALE—Three Worthington horizontal duplex hot oil pumps, 23 x 5 x 24, with forged steel liquid ends, rated 750 pounds square inch discharge pressure. Used in refinery operation. Good for irrigation projects, plastic industry, paper plants. Good condition. R. H. Armstrong, Republic Oil Refining Company, Texas City, Texas.

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Opportunity for considerable responsibility for engineer 28-45 years who has degree in mechanical or metallurgical engineering or the demonstrated technical background in these fields in addition to five (5) years experience in petroleum refinery equipment inspection.

Must have solid background of general knowledge of metallurgical and mechanical aspects of corrosion and other factors contributing to deterioration of refinery materials.

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Ten years supervisory experience in engine maintenance and machine shop practice. Familiarization with oil refinery machinery desirable but not essential. Write giving training, experience, references and personal details to:

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(30-35) New York District Sales Agency well established desires man familiar process equipment such as chemical or power; resident New York zone, for industrial plant contact. Some sales experience desirable, not essential. Correct personality, initiative and dependability important for congenial successful association small group. Address: Box 139-R, c/o Petroleum Refiner, Houston, Texas.

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with experience in refinery and chemical type pumps

Must have thorough knowledge of various types of pumps and their application, packing, seal oil systems, materials of construction, and be able to write specifications, select proper equipment and assist in designing installations. Applicant should have about ten years' experience. **Location: New England.** Address: Box 140-R, c/o Petroleum Refiner, Houston, Texas.

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Engineer to direct Sales of Refinery process units. Qualifications to include sales and process engineering experience with major oil companies or petroleum engineering and contracting firms. Knowledge of oil refining process engineering plus economic evaluations and applications necessary. Age 35 to 45 years. Excellent compensation — salary and bonus. Location — New York or Tulsa. When replying state educational and experience background. Our own employees notified of opening. Address: Box 138-R, c/o Petroleum Refiner, Houston, Texas.

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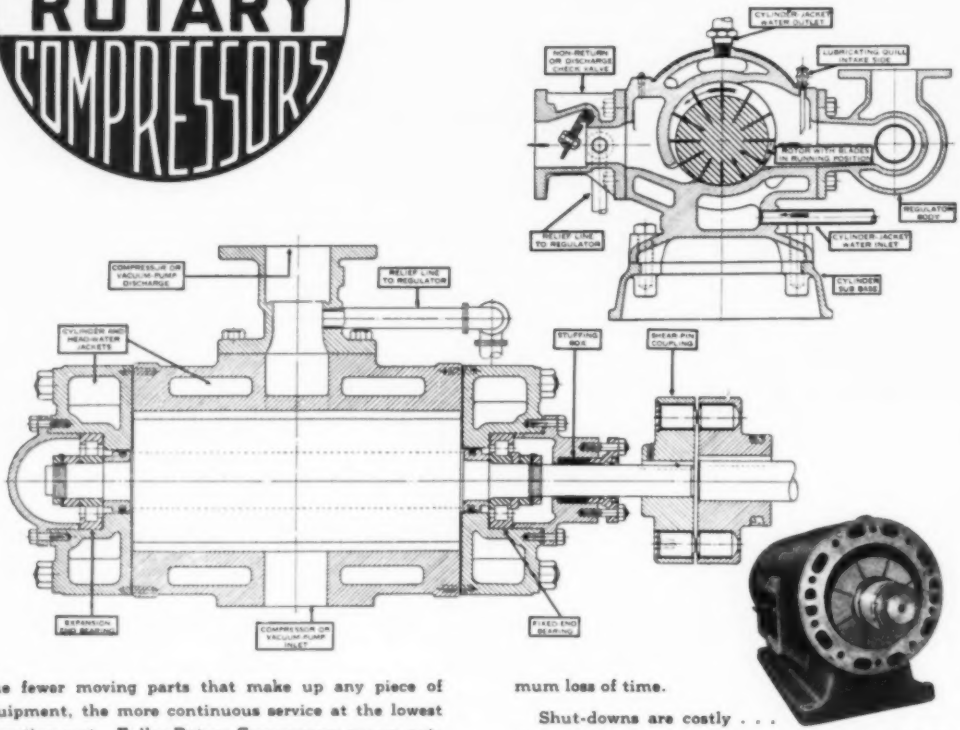
Joseph Coy Company Moves

Joseph A. Coy Company has moved its Houston office to a new location at 4101 San Jacinto. C. Shults Faulkner, district manager, is in charge of the Houston office.

Rugged Construction . . .
Simplicity of Design . . .
Minimum of Moving Parts
Rotor - Bearings - Blades

FULLER ROTARY COMPRESSORS



The fewer moving parts that make up any piece of equipment, the more continuous service at the lowest operating cost. Fuller Rotary Compressors are an outstanding example of simplicity of design . . . few moving parts: rotor—bearings—blades.

Ruggedly constructed, they will withstand long, continuous service and, after severe, gruelling operating periods, if inspection and check-up is desired, the machine design permits doing this easily and with a minimum loss of time.

Shut-downs are costly . . . lost time can never be recovered . . . install Fullers for day in, and day out, continuous service.

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C-185

Provide extra stamina, and resistance to erosion and corrosion

FOSTER WHEELER used approximately 70 tons of 70-30 cupro-nickel tubing (¾" OD x 13 BWG) for this and 11 similar high pressure feedwater heaters.

USE 70-30 CUPRO-NICKEL TUBING

in feed water heaters, condensers, and evaporators

Performance of 70-30 cupro-nickel tubing in marine applications...especially in naval service ... has proved the dependability of this alloy under severe operating conditions.

Its resistance to pitting and other forms of corrosion is outstanding. The notable service records it has established in salt water service amply justify its use in other fields where corrosive and erosive effects of water and steam are encountered.

Such applications include heat exchangers in the petroleum and chemical industries, condensers in shore power stations, and feed water heaters everywhere. A typical example is the above unit built by Foster Wheeler Corporation of New York City.

In applications of this sort the cupro-nickel alloy offers the advantages of superior strength at high temperatures and superior resistance to ammonia and other corrosive contaminants of steam.

Cupro-nickel makes possible high economies. Enjoy all the advantages this alloy offers. Send us details of your tubing problems, for our suggestions. Write us today.

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Over the years International Nickel has accumulated a fund of useful information on the properties, treatment, fabrication and performance of engineering alloy steels, stainless steels, cast irons, brasses, bronzes, nickel silver, cupro-nickel and other alloys containing nickel. This information is yours for the asking. Write for "List A" of available publications.

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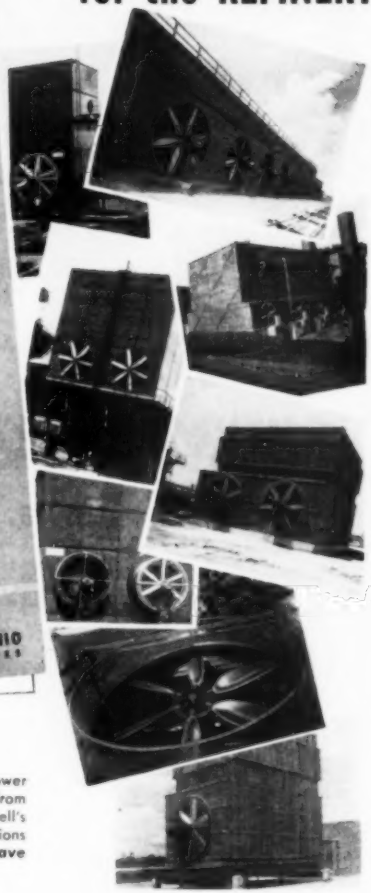
COOLING TOWER FANS for the REFINERY



A Few Typical Hartzell Cooling Tower Fan Installations

Look at the record—the ***Hartzell*** record—if you think there isn't a cooling tower fan in large sizes which can successfully combat the ravages of corrosion (from acids, alkalies, salt water) and vibration. You'll find that ever since 1941, Hartzell's cooling tower fans of Hartzite plastic have been standing up against conditions which throw the ordinary fan for a loss. ***Where they have been tried they have been specified regularly on following towers for the same user.***

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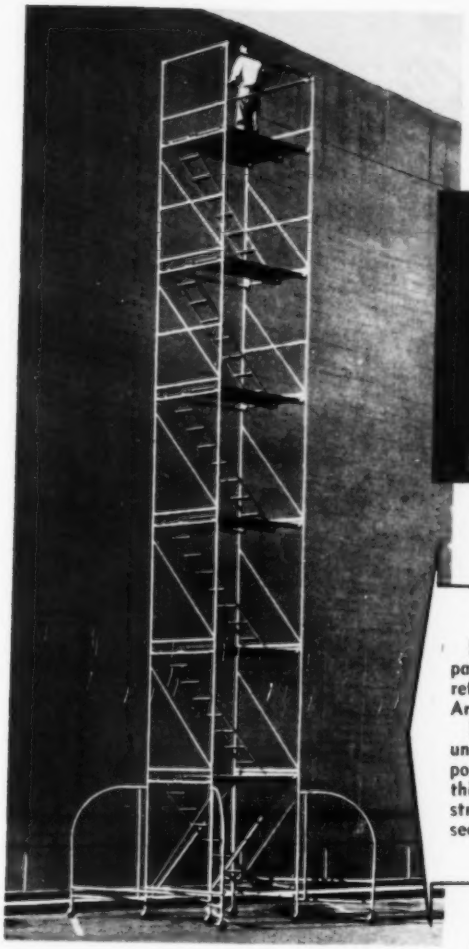

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with Revolutionary, new . . .

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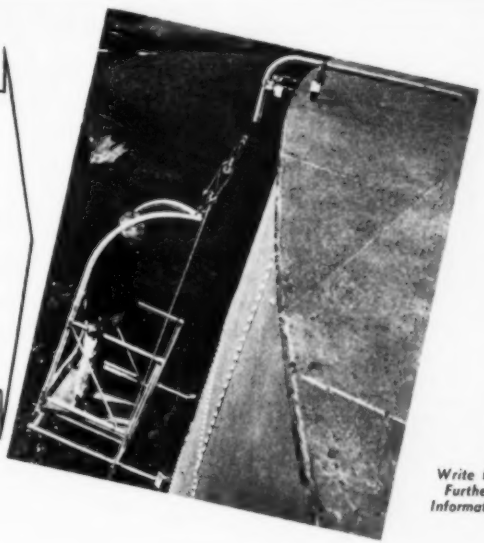
Mobile 45′ unit takes only 15 minutes to erect!

Scores of refinery users report big labor savings on tank painting, cleaning, inspection, repairing and general overhead refinery maintenance with Up-Right Scaffolds and Roll-Around Safety Cage.

Scaffolds are available in desired number of 6-foot section units for rapid, easy assembly. Roll easily from position to position throughout job. Stronger than structural steel yet one third the weight. Safety tread stairway completely within structure. No wrenches, wing nuts, bolts, loose parts. Each section folds flat.

Roll-Around Safety Cage, anchored to eye-bolt on top of tank, provides a new, faster method for covering entire wall areas of tanks. Weighs only 95 lbs., and its unique design permits the use of pole guns and bulky maintenance equipment. Unusual safety features include widely spaced legs which eliminate wind hazards.



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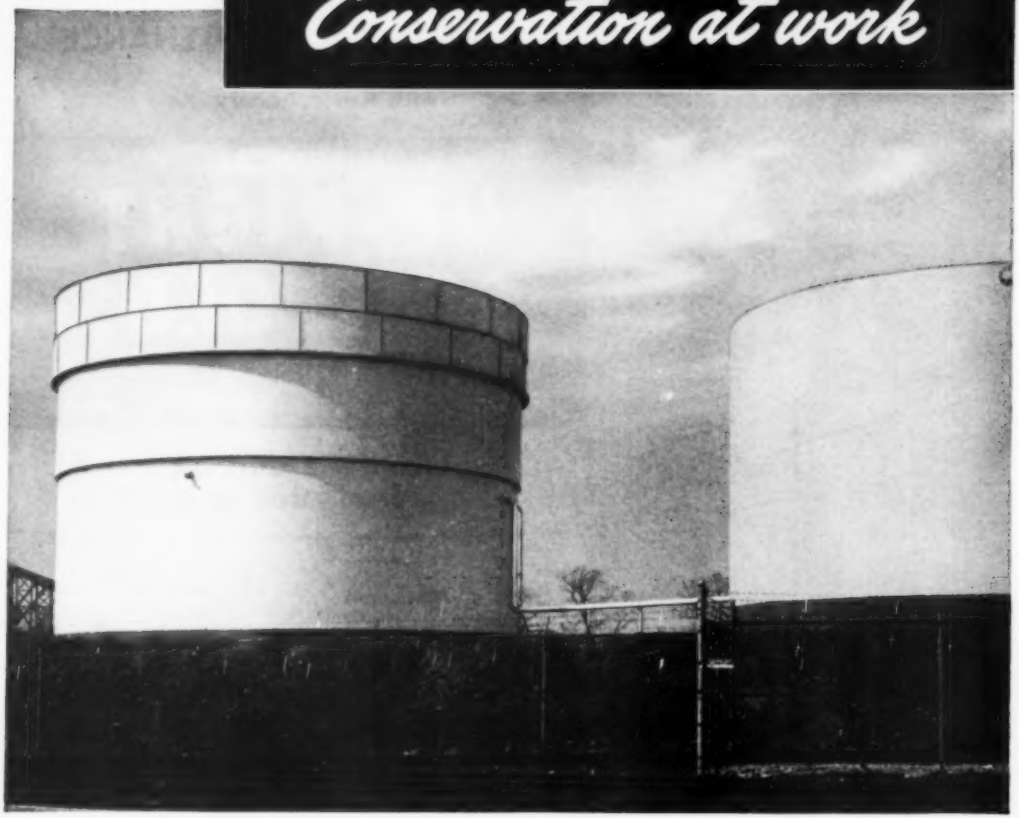

THE EXPANSION ROOF ENDS MAINTENANCE COSTS

In the ten years during which Expansion Roof Tanks have been providing vapor loss protection in all parts of the world, maintenance has been limited to only such painting as any steel structure requires. Simplicity of design is the reason. The vapor seal is liquid . . . there is no fabric to wear. All mechanism is enclosed, yet readily accessible . . . there are no exposed tracks or counter-balancing assemblies to weather.

In addition, the Expansion Roof offers ease and accuracy of gauging and perfect roof drainage outside of the tank rather than through storage.

To put low-cost vapor loss protection to work for you, call Graver today. Tank sizes and expansion capacities are available for all single and multiple tank installations.

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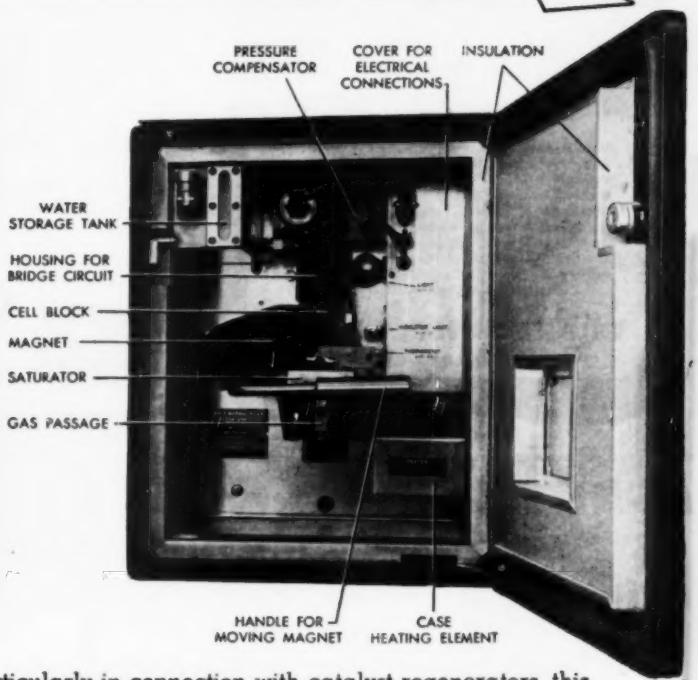
that the oil refineries have been waiting for

The **HAYS** MAGNO-THERM **OXYGEN ANALYZER**



Particularly in connection with catalyst regenerators, this Oxygen Meter has been tested and proved in service to measure oxygen with sustained accuracy and dependability.

Operates on an entirely new principle based on the paramagnetic property of oxygen. No combustion required—no fuel has to be added. Temperature of gas analyzing cell is too low to support combustion, which is a strong safety feature.

One large refinery superintendent says, "After testing several oxygen meters, we find the Hays meter to be operating on the best principle. We like its simplicity, its design, its method of operation, and its rugged construction."

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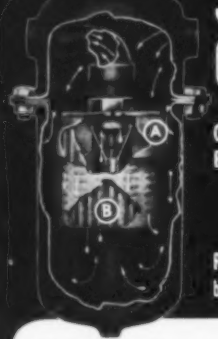

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Principle Guarantees both CLEAN & DRY gas

Removes injurious pipe scale, rust, dust, dirt, water and other foreign matter from artificial or natural gas. Filter employs both mechanical separation and filtration. Deflector cup (A) directs gas to walls of housing, thence to base where heavier particles and liquids are deposited. Gas then rises thru exclusive Radial Fin Insert (B) where lighter particles are removed. Use steadily increasing in petroleum industry.

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MATERIALS • METHODS • SERVICE

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- Complete Visibility
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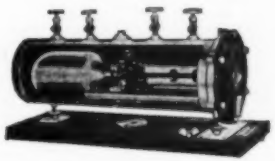
Sturdy construction and simplicity of operation contribute to accurate operation with a minimum of maintenance.

The instrument does not contain rotating parts thereby eliminating a major source of wear. The accuracy and practicability of Refinery Supply Company equipment are the result of scientific and sound manufacturing procedures combined with materials of proven integrity.

Can Be Equipped with Automatic Controls.



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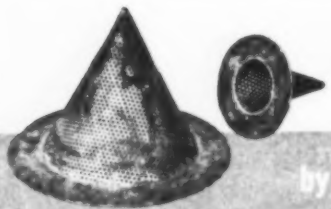

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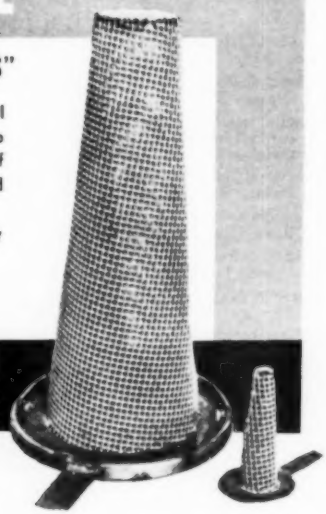

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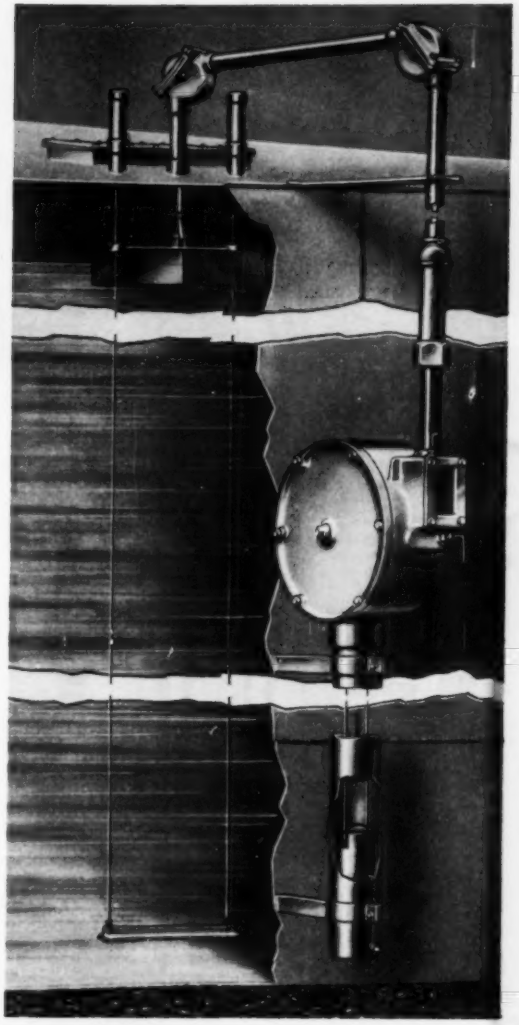
We know, of course, that there are thousands of storage tanks in all parts of the world, where men still have to climb to the tank top, open a gauge hole cover, lower a graduated steel tape and record the reading in an inventory book.

That method is slow, dangerous, expensive, and far less accurate than automatic gauging, in which the gauger merely takes a reading of the tape at ground level—eliminating the dangers of climbing ladders in all kinds of weather, damage to tank tops, personal hazards of asphixiation.

We manufacture a complete line of automatic tank gauges which are applicable to practically every type of storage tank used in the petroleum industry, so no matter how ancient the vintage of your tanks, no matter what type of roof—we can supply you with an automatic tank gauge.



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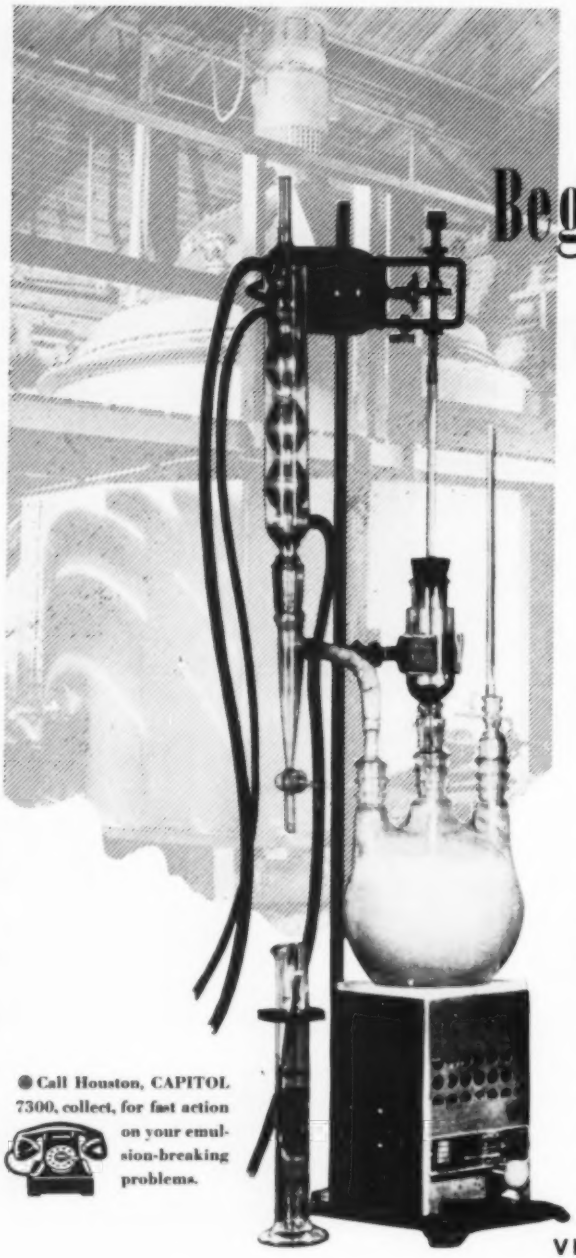

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to Solve Your Emulsion-Breaking Problems . . .

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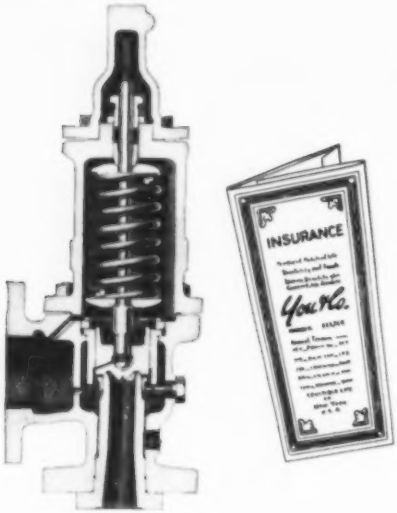

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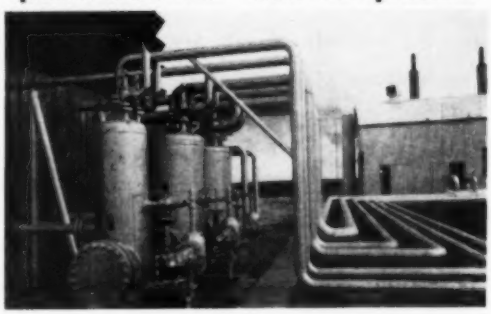

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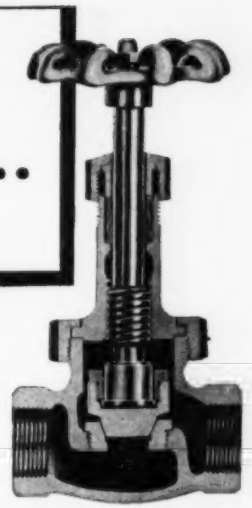

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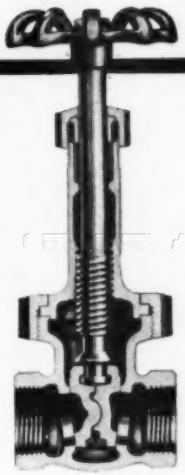

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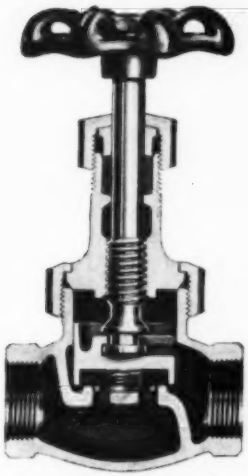

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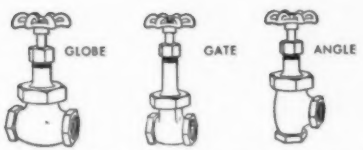

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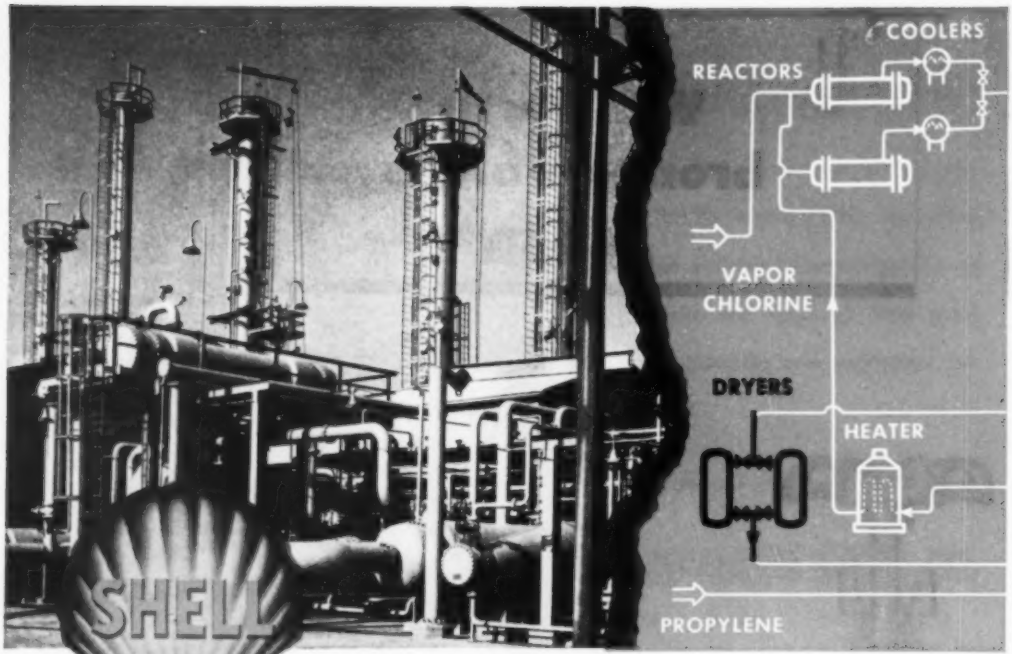

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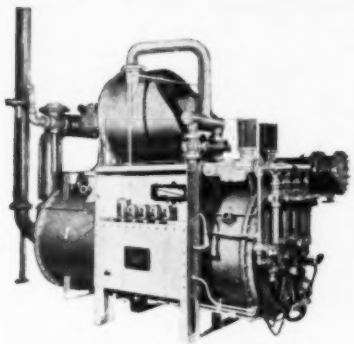

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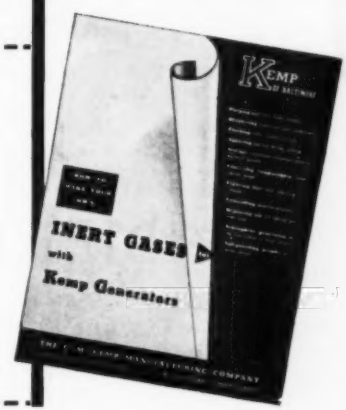

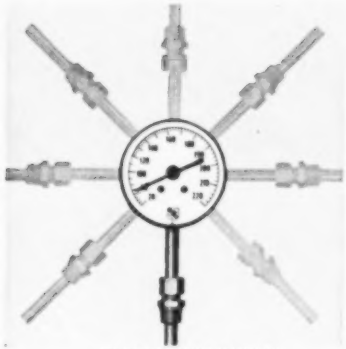

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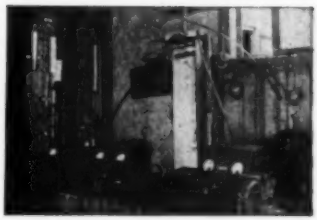

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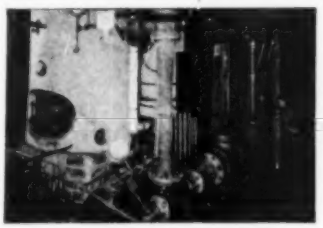

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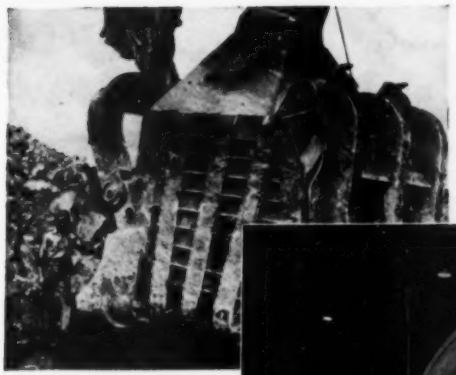

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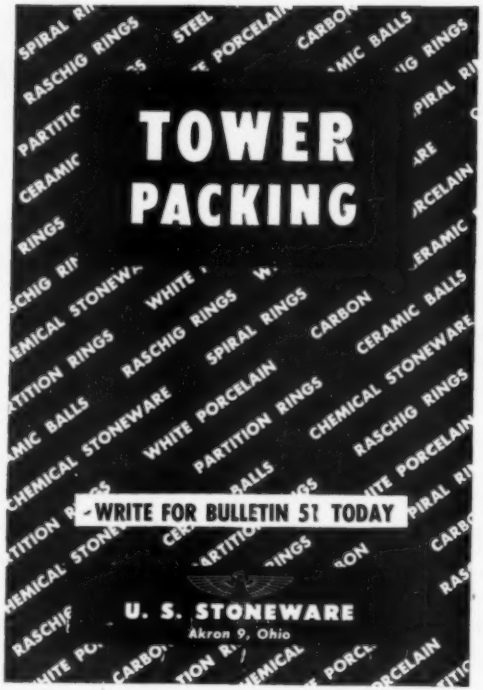

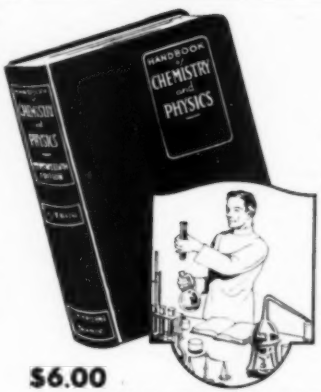

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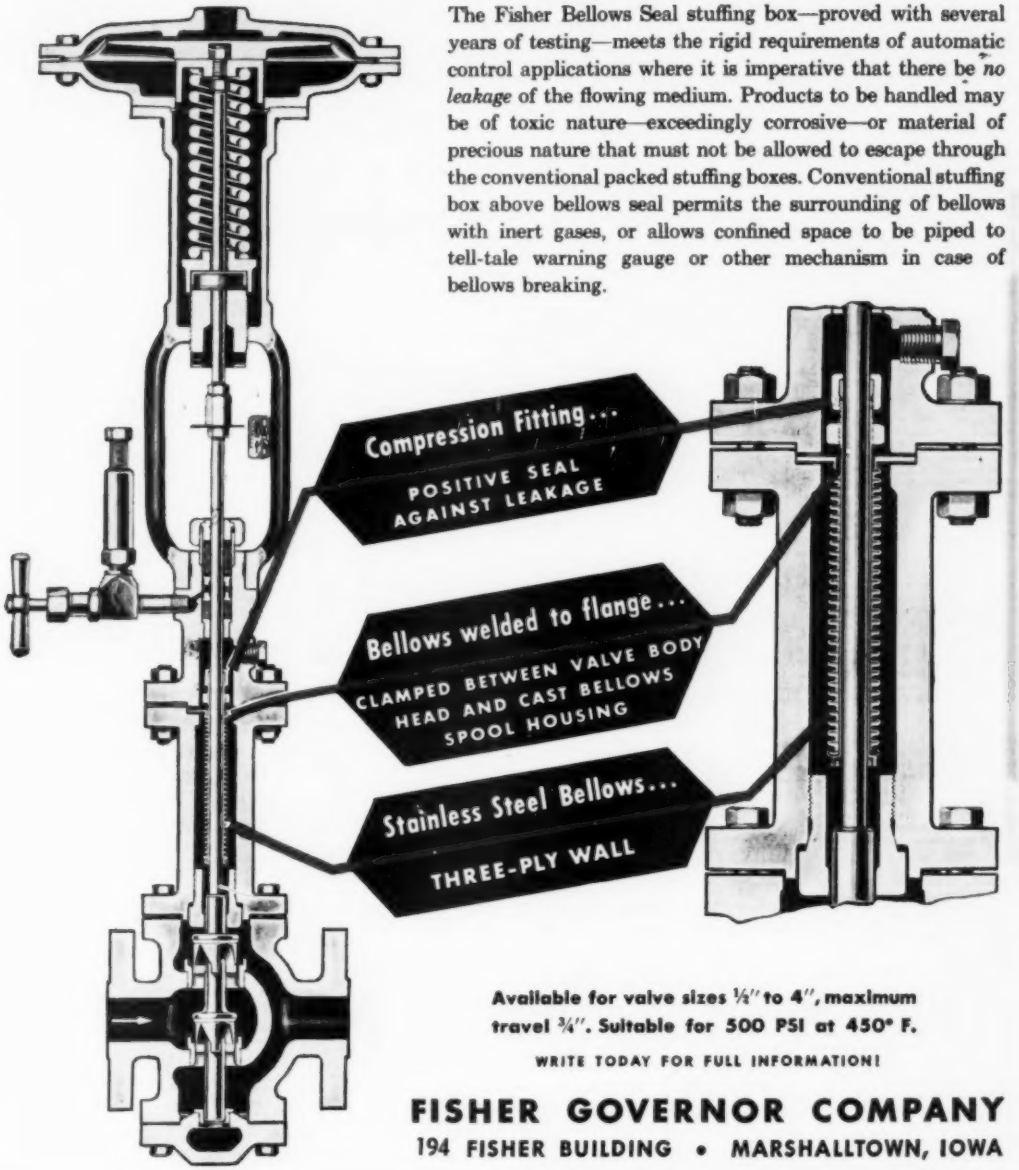
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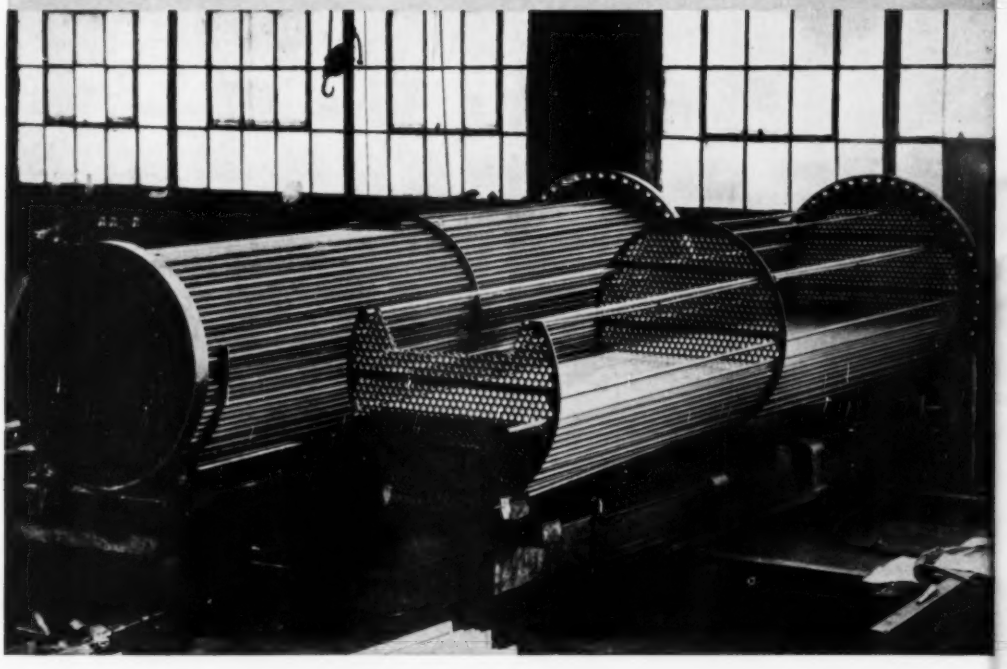
IT'S IMPORTANT TO KNOW ALL THE FACTORS AFFECTING CONDENSER TUBES



In selecting condenser tubes it is often the case that such conditions as temperatures, pressures, and compositions of the gases and fluids will be taken into account fully, only to have the tubes thus chosen give short service. In such cases, it is wise to call in Revere and ask for a thorough check of the situation before assuming that the wrong alloy was specified.

Here is a case in point. Admiralty tubes in a high stage condenser in a refinery were lasting only three or four months. In the effort to increase life, the sour gas had been treated, but as no improvement was experienced, the treatment was discontinued. The Revere Research report, made after laboratory investigation, stated that Admiralty metal was the correct alloy and its use should be continued, but that microscopic study of a failed tube showed definite and conclusive evidence of fatigue corrosion, probably due to vibration. A conference with the people at the plant revealed that the condenser vibrated considerably. Hence the obvious recommendations: cut down the vibration by better bracing, resume treatment of the gas, and continue to use Admiralty tubes. These recommendations were followed, and when last checked the new Admiralty tubes had been serving for eight months and were still going.

The Revere Technical Advisory Service is eager to serve all users of condenser tubes and plates through close collaboration in the study of difficult problems.

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WITH a wide range of style numbers, "Oilwell" can supply a Goetze Gasket to meet every service requirement of the oil industry.

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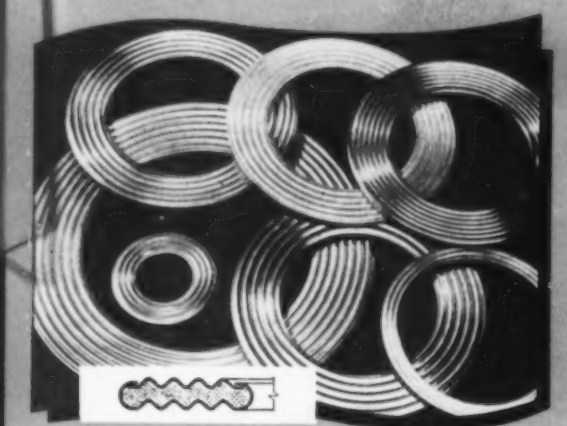
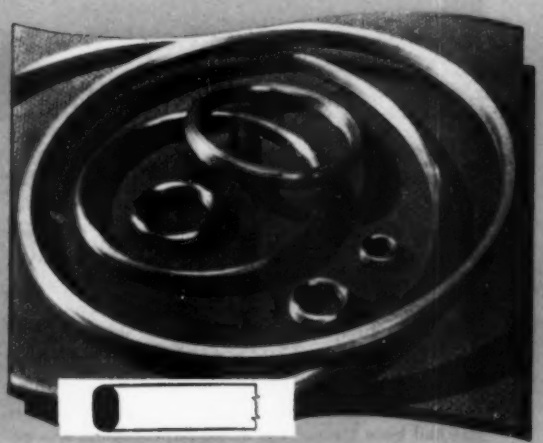


STYLE NO. 926 Corrugated metal-asbestos, combining strength with resilience. Standard specifications: Metal, .019" soft steel, .019" copper, .018" aluminum and .018" Monel; Filler 1/16" or 1/8" asbestos millboard; Thickness, approximately 1/8".



STYLE NO. 950 "V-Tite" oval for ring-type joints, available in all standard A.P.I. sizes as well as special dimension or cross-section, in 11 grades of various metals for service temperatures, ranging from sub-zero to plus 1700°F.

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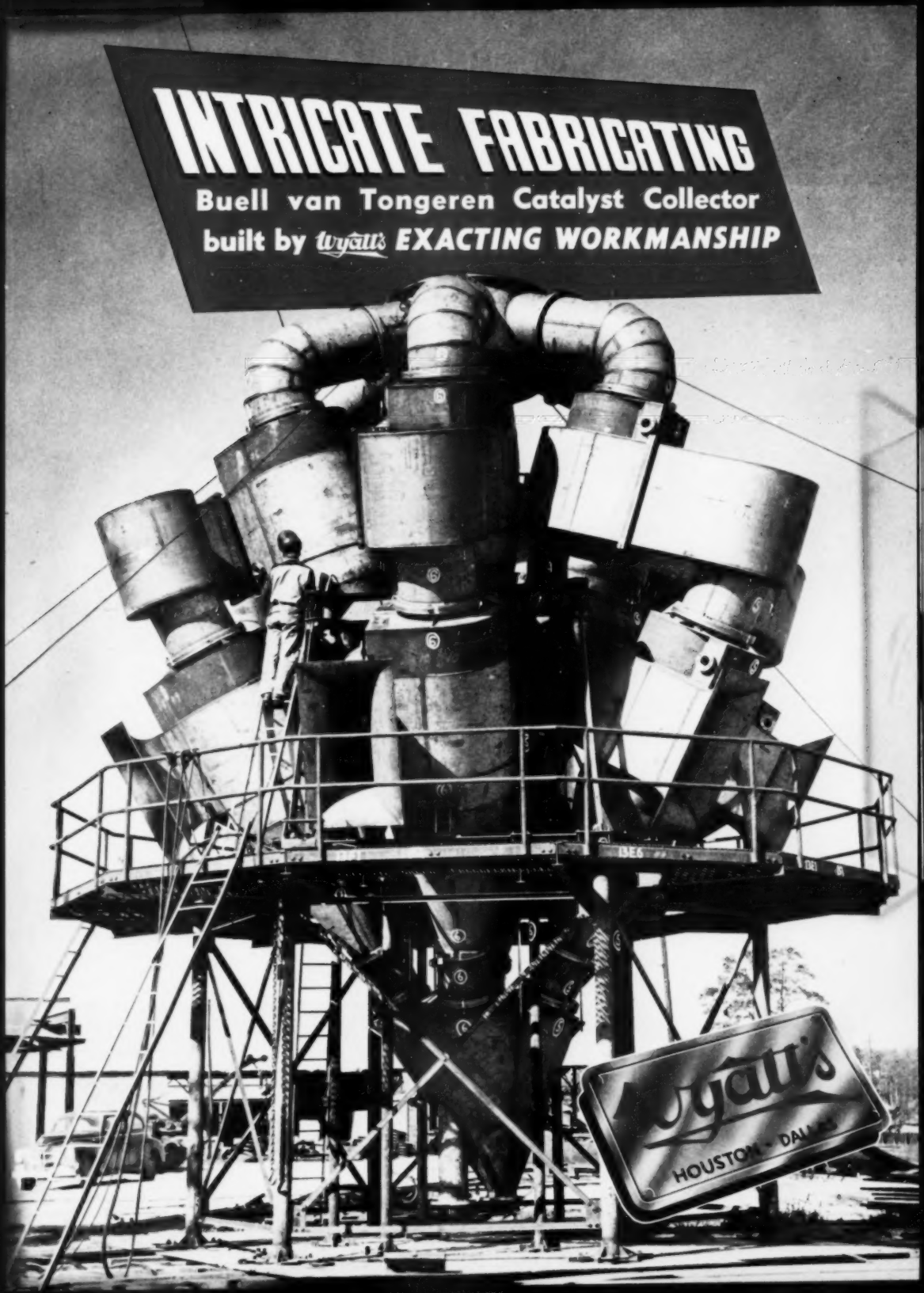
UNITED STATES STEEL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HOUSTON - DALLAS

McDONALD

Swing Joints

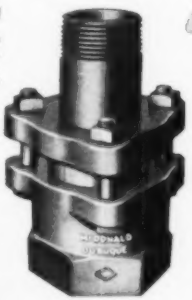

Plate 889—McDonald Standard Swing Joint (Straight). Iron body, bolted iron gland, bronze ferrule. Available in 1¼", 1½", 2", 2½", 3", and 4" sizes.

Plate 814—McDonald Standard Swing Joint (Double). ¾", 1", 1¼", 1½", 2", 2½", 3", 4", 6", 8", 10".

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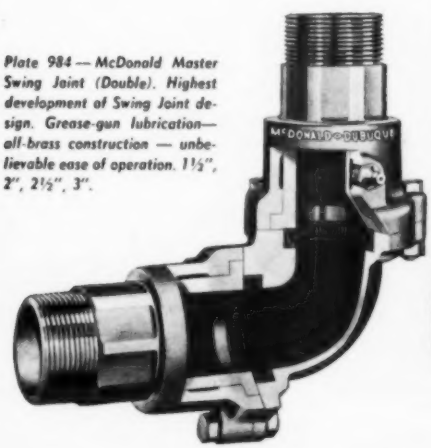

Plate 984 — McDonald Master Swing Joint (Double). Highest development of Swing Joint design. Grease-gun lubrication—all-brass construction — unbelievable ease of operation. 1½", 2", 2½", 3".

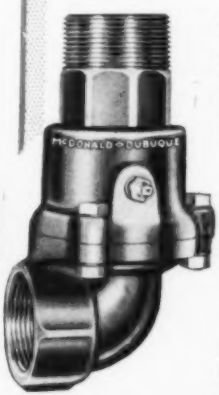

Plate 983—McDonald Master Swing Joint (Single). A single ring is used for packing—replaceable, if required, in jiffy-quick time. 1½", 2", 2½", 3".

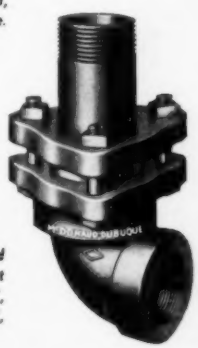

Plate 813—McDonald Standard Swing Joint (Single). ¾", 1", 1¼", 1½", 2", 2½", 3", 4", 6", 8", 10."